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THE CELL CONTENT OF MILK

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The uncertainty of the meaning of the cellular content in milk is apparently either a measure of the lack of differentiation of the cells occurring normally or abnormally in cow's milk, or it would seem to us, due to defective technic in the differentiation of those cells. The latter is shown by those laboratory workers who, while they believe in the smear method of examining milk, yet by failure to employ a differential stain, miss the point at issue. The latter has been demonstrated to us by the use of gentian-violet alone. In a previous article,[1] we have shown that differentiation by any blood-stain such as the one we were using at the time, a 1 per cent. eosin methyl-alcohol followed by a 1 per cent. methylene blue methyl-alcohol, or its counterpart, the Jenner stain, or again the latter modifications of that stain, the Wright, and the one we are now using entirely, the Hastings stain, gives us a picture with sharp differentiation. The interpretation of that picture is one more of experience than of judgment, as we have already shown. That it is a measure of the lack of differentiation is shown frequently by the type of the article discussing this most important subject. A recent one,[2] like the majority of those which appear in print, is not apparently from a laboratory worker who has been trained along these lines, but by a thesis writer who deduces wide conclusions from a small amount of data.

In direct criticism of this article as a typical one of the class of which we speak, we would call attention to certain statements made. While agreeing that "some of the cells found in milk are leukocytes," the writer also states that it is by no means certain that some of them are not epithelial cells. Without attempting to differentiate these types of cells, with examination of samples from 50 cows, the cell content ranging from 4,000 to 3,576,000, the conclusion is deduced that the "formation of the cells, or leukocytes, is a normal function of milk production." This conclusion is verified as claimed, by physical examination of the cows, showing an absence of cow troubles. The fallacy lies in the fact, as we

1. Ross, H. E.: Jour. Infect. Dis., 1912, x, 7.
2. Lewis, D. M.: Jour. Am. Pub. Health Assn., 1911, p. 778.

have stated, that leukocytes constitute only part of the cellular content of milk. One may find the following cells present in the milk sediment when stained with any blood-stain: Epithelial or endothelial cells, varying sized mononuclear cells with basic granule content; polymorphonuclear neutrophils, free or clumped; eosinophils; lymphocytes, so-called because they are the exact analogue of the human lymphocyte; red blood-corpuscles. A study of the illustrations in the accompanying plate made for us by Mr. Kellner of the Yale Clinical Laboratory, shows well these types of cells. It is a lax, but universal, way of terming leukocytes as pus cells and meaning only polymorphonuclear neutrophils. The lymphocyte, while a leukocyte, we have not included in the terminology of pus cells, restricting the latter to polymorphonuclear neutrophils and eosinophils. The difference of staining qualities of the pus cell is well shown in the contrast between Illustrations 1 and 2. The former was from an older milk, and the pus cells were so piled up that it was impossible to make an accurate count. The latter illustration was from a fresh milk in which the pus cells are well differentiated. Illustration 1 shows also a number of epithelial cells and a few lymphocytes, while No. 2 shows no other cells than the pus cells. Illustration 3 shows epithelial and lymphocytes predominating, rarely a free pus cell. As we have previously stated, we have never traced cow trouble to sediment smears similar to the latter, nor have we ever seen the characteristic long chain streptococci accompanying such cellular content. Such a cellular content is common and may easily be the explanation of why there may be 3,576,000 cells in milk samples, and yet physical examination of the milk show nothing. The cellular content of the milk represented by Illustration 2 was approximately 440,000, while that of Illustration 3 was approximately 1,000,000; the former milk was from a herd in which one cow had an infected quarter; the latter showed no herd troubles. In a previous paper, we have stated that there can be no standard for cellular content; we more frequently find milk samples containing 50,000 pus cells to the cubic centimeter, but these pus cells clumped, than we do those in which the content is millions or uncountable, both accompanied by long chain streptococci. We find the former are dependent on parturition or lesser inflammatory troubles of single quarters, while the latter are true garget. We have not pictured samples showing red blood-corpuscles, as these are very obvious, and where in any number not accountable for by pus content, mean cows milked too soon after parturition. Here again, in a minor number of cases, is the lack of a correct stain an error in interpretation of the smear.

We have evidence to show that no major or minor cow troubles ever give an epithelial or lymphocytic cell content apart from clumped pus cells, and would recommend that pus content of milk as generally spoken

of, should mean polymorphonuclear neutrophilic or eosinophilic cells; and further, only when these cells are clumped and in whatsoever numbers. In practically every instance in which streptococci are not found, the characteristic chains may be demonstrated after incubation of the specimen, or when a sample from the cow direct is obtained.

Although, as we have stated, counts of cells from milk samples may range from a few thousand to millions, and on the basis of what has gone before, be corroborated by lack of physical findings of cow disorders, because of the absence of differential counts on the individual cows in the criticized article, we collected the following data after the appearance of that article. For the added reason that generally we are dealing with market milk representing single or numerous herds, we give data from both individual cows and from market samples. We would again state that we use the original Stewart method of centrifugalizing 1 cubic centimeter of milk for ten minutes, rubbing up the sediment over an area approximately 1 square centimeter, and staining with Hastings blood-stain. Each oil immersion field represents 1/4400 part of a cubic centimeter, and we average at least twelve fields.

TABLE 1. SUMMARY OF EXAMINATION OF MILK OF INDIVIDUAL COWS AND SAMPLES OF MARKET MILK

	Individual Cows, 88 Samples	Market Milk, 108 Samples
Samples showing no cell content per average field	20	42
Samples showing less than 5 epithelial cells per average field	31	36
Samples showing less than 10 epithelial cells per average field	5	1
Samples showing 10 to 50 epithelial cells per average field	2	0
Samples showing less than 5 epithelial and pus cells per av. field	7	19
Samples showing less than 10 epithelial and pus cells per av. field	2	6
Samples showing less than 15 epithelial and pus cells per av. field	1	1
Samples showing less than 5 free pus cells per average field	0	0
Samples showing less than 10 free pus cells per average field	5	2
Samples showing less than 15 free pus cells per average field	1	1
Samples showing less clumped pus and epithelial cells, 20 to 100	14	0

The table of individual cow samples were from three different herds in which cow troubles had been traced from market milk examination. The samples of market milk were consecutive ones in the interim between market milk samples that showed trouble, that is, selected to the extent of not showing herd troubles.

We offer the accompanying tables to show how small may be the cell content of individual cows of one herd in which there was trouble, contrasted with one to show how much might be the trouble encountered in lax milk producers:

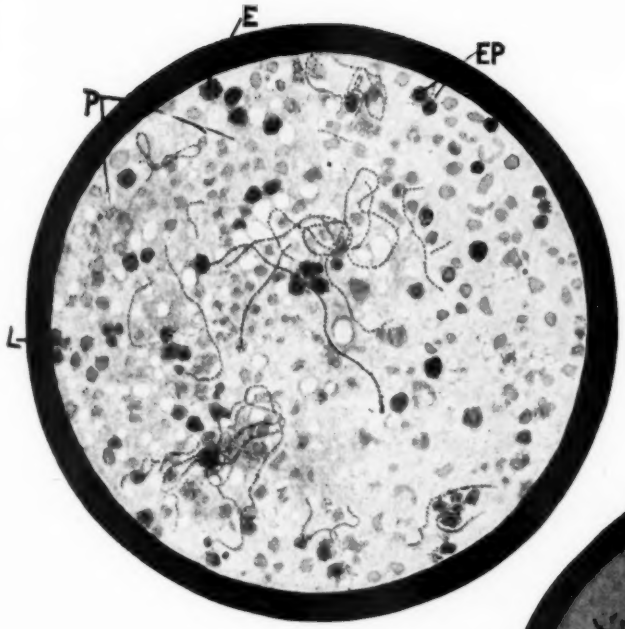
TABLE 2. CELL CONTENT OF MILK FROM HERD IN WHICH THERE WAS TROUBLE, CONTRASTED WITH THAT FROM HERD CARELESSLY HANDLED

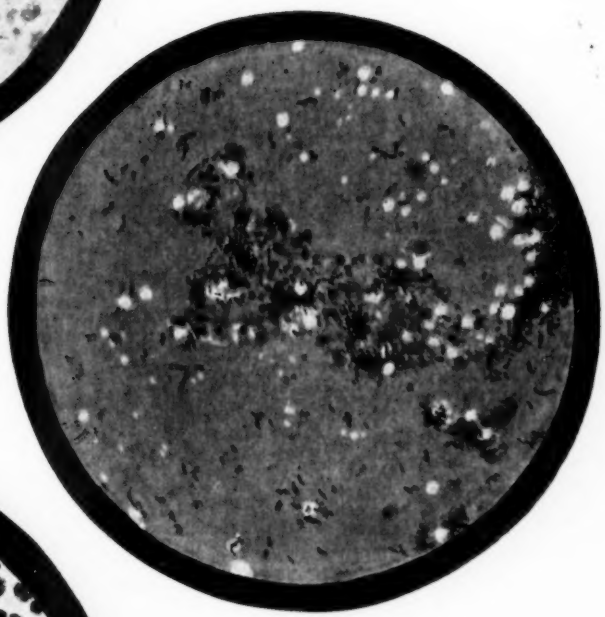
Cow No	Epithelial Cells		Polymorphonuclears		Eosinophils		Lymphocytes		Red Blood Cells	
	Herd 1	Herd 2	Herd 1	Herd 2	Herd 1	Herd 2	Herd 1	Herd 2	Herd 1	Herd 2
1	2	2	0	1	0	0	4	0	0	0
2	1	3	0	†*	0	15	2	0	0	0
3	0	5	0	50*	0	0	0	0	0	0
4	1	1	1	1	1	0	0	0	0	0
5	3	1	100*	2	3	0	0	0	4	0
6	15	0	†*	0	25	0	0	0	0	0
7	2	5	3	1	0	0	0	0	0	0
8	1	2	1	0	0	0	0	0	0	0
9	1	30	0	65*	0	2	0	0	0	0
10	0	25	0	30*	0	0	0	0	0	0
11	0	5	0	25*	0	0	0	0	0	0
12	2	3	0	10	0	0	0	0	0	0
13	0		0		0		0		0	
14	0		1		0		0		0	
15	1		0		0		0		0	
16	1		0		0		0		0	
17	1		1		0		0		0	
18	1		1		0		1		0	

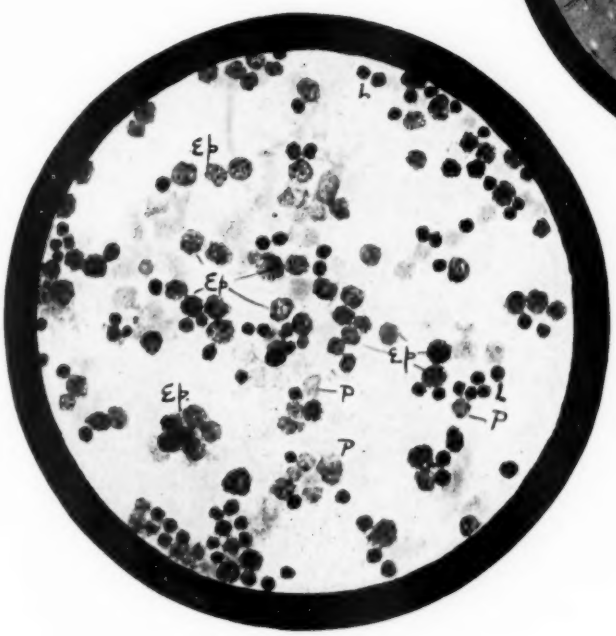
* Clumped. † Uncountable.

Out of the first herd of eighteen cows we have two cows at fault; one showed garget, the other an infected quarter. The second herd showed five cows at fault out of twelve, and all of them on examination showed varying grades of localized single-quarter, udder involvement. The producer of the milk of the second herd had picked out the cows previously, but because the milk was not "real stringy," and because he was short of milk, thought it would be safe enough to include these cows.

In the article under criticism, there is given a short report on the wide variation in the cell content on comparative counts of the fore-milk, the middle-milk and the strippings, examination of fifteen samples showing 53.85 per cent. increase of the strippings content over that of the fore-milk, and 52.14 per cent. in the strippings over the middle-milk. If this is put the other way, it reads that the fore- and middle-milk vary by but 1.74 per cent., while the strippings contain all the cells. This was of interest to us, in that we had not previously cared what portion of a cow's milk was sent to us for examination for inflammatory or minor grade troubles. Would this modify our results? Secondly, what might be the difference of cellular content in a differential count of normal, and, of more importance, of infected animals. Having gained an impression during the past four years' work on milk that there might be some relation between the cellular content of milk other than pus cells, and the period previous to, or following calving, together with the factor







EXPLANATION OF PLATES

Ep = Epithelial cells.
E = Eosinophils.
P = Polymorphonuclear neutrophils.
L = Lymphocytes.

ILLUSTRATING ARTICLE BY DR. D. M. LEWIS

of the age of the cow, we asked one of our most careful producers to pick us out six good cows of varying ages and varying terms following calving. We already appreciated that the majority of the minor cow troubles follow calving; would the strippings of cows at this time tell us anything that the first milk would not?

The data will be found in Table 3.

TABLE 3.—Cell Content of Strippings from Selected Cows at Various Periods After Calving

Cow 1. Young cow, one month following calving:
Fore-milk..... 4 epithelial, 6 polymorphonuclears (free)
Middle-milk..... 2 epithelial, 4 polymorphonuclears (free)
Stripplings..... 4 epithelial, 3 polymorphonuclears (free)

Cow 2. Young cow, three weeks after calving:
Fore-milk..... 3 epithelial, 1 polymorphonuclear, 1 lymphocyte
Middle-milk..... 5 epithelial, 1 polymorphonuclear, 1 lymphocyte
Strippings.....20 epithelial, 6 polymorphonuclears (free)

Cow 3. Young cow, seven months after calving:
Fore-milk..... 2 epithelial, 4 polymorphonuclear (free)
Middle-milk..... 5 epithelial, 2 polymorphonuclear (free)
Stripping..s.....10 epithelial, 8 polymorphonuclear (free)

Cow 4. Young cow, eight months after calving:
Fore-milk..... 1 epithelial, 0 polymorphonuclear
Middle-milk..... 3 epithelial, 1 polymorphonuclear
Strippings..... 4 epithelial, 1 polymorphonuclear

Cow 5. Ten years old, one year after calving:
Fore-milk..... 3 epithelial, 4 polymorphonuclear (free)
Middle-milk..... 4 epithelial, 4 polymorphonuclear (free)
Strippings..... 4 epithelial, 6 polymorphonuclear (free)

Cow 6. Ten years old, three weeks after calving:
Fore-milk.....22 epithelial, 150 polymorphonuclear (clumped)
Middle-milk.....60 epithelial, 20 polymorphonuclear (clumped)
Strippings.....38 epithelial, 150 polymorphonuclear (clumped)
2 eosinophils. 2 red blood cells.

The last cow was stated to have been out of condition and but for being in-calf would have previously been sold for beef. Typical long-chain streptococci were present in the three samples of the last cow.

Comparison of this data bears out the contention that the strippings may contain 50 per cent. more cells, as in two out of five uninvolved cows here given, but that in the single involved case, the fore-milk gave as much data as the strippings. It might be well, if there is any number of pus cells to be determined as a standard, that equal portions of fore-milk, middle-milk and strippings be obtained, yet for the purpose of diagnosis, this would not seem to be necessary.

We might well relate a recent personal experience of how exact this differential smear method is. We provide for a boy 2 years of age a milk produced by one of the most careful dairymen of this vicinity, who

rightly charges an extra price for his milk, and who is generally recommended as one producing one of the best milks for babies.

The boy refused this milk only at intervals the first day after a return from the country where he had been for a week. The following morning, having a diarrhea, we examined the milk and found but an average of 7 and 8 polymorphonuclears per field and an absence of streptococci. The pus cells were clumped, and incubation of the sample failed to show streptococci. A specimen the following morning showing the same findings, we believed it was either the beginning or ending of some cow trouble. That day we were asked from three different sources, each one a family where there was a baby, on this milk, ill with diarrhea for from four days to a week, if there was any trouble with this producer's milk. We asked the producer to have his herd gone through for some minor grade of cow trouble, giving him the above history. Unable to find anything wrong, his examination was followed by a veterinarian with no better results. In the meantime, we were told of two further cases of babies on that milk ill with diarrhea. We then volunteered to examine the individual cows through milk samples from each. In rubbing up the sediments of the 50 samples sent in, one was distinctly ropy, and on examination showed uncountable pus with accompanying chain-streptococci. Of the remainder, two showed average fields of 2 and 3 pus cells, two showed red blood-corpuscles, averaging 4 and 5 per field. The latter samples were from cows, one in for the first time, the other had been in for twenty-one days. Of the two samples showing the few pus cells, one was from a cow in heat, the other from a cow being dried off. The cow showing the main trouble was apparently free from disease, and is being watched for developments. We suspect that this cow is tuberculous and later shall ask for the proof if the trouble does not clear up.

A coincidence might be spoken of here. At the same time, with relative freedom from sore throats, a pediatrician told us of three cases of injected throats, high temperature and gland enlargement, though without the prostration of the usual streptococcus infections. These three cases were in different families, but on the same milk.

CONCLUSIONS

Clumped polymorphonuclear and eosinophilic leukocytes, in whatsoever numbers, accompanied by long-chain streptococci, mean cow troubles. Absence of streptococci does not mean that they will not be found when the original source of the trouble is located.

A differential blood-stain is a most important essential.

The Doane-Buckley volumetric method, scientifically accurate for cell counts, is inferior to a less accurate but differential count.

Laboratories setting any standard for a pus cell content as meaning cow troubles will frequently miss opportunities for preventing further infections.

NOTE.—Since this was written we have received the Report of the New York Milk Committee, and believe that this article answers the questioned findings of Articles 6, 7 and 8 of the Appendix. We would again emphasize the fact that it is not clumped cells (which may be clumped epithelial cells) which suggest inflammatory troubles, but clumped polymorphonuclear or eosinophilic cells. Again, we take issue with "chain-forming streptococci with at least six elements in a chain, alone, as sufficient to suggest udder troubles." That it is not, we have shown in a previous article. We are at present at work on a further article on streptococci in milk with further data on this point.

THE FURTHER STUDY OF THE ANATOMY AND PHYSIOLOGY OF THE INFANT STOMACH BASED ON SERIAL ROENTGENOGRAMS *

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Although the advances in roentgenology of the internal organs during the past few years have been truly remarkable, developing it into a highly specialized division of medical science, comparatively little research work has been done in the department of pediatrics. This was apparently not due to lack of inclination, but to the natural limitations imposed by a technic not sufficiently developed to make extended work with infants and young children possible.

The long exposures formerly necessary made it impractical to get radiographs of unruly infants with any detail, and, furthermore, there was always the danger of injury. Anesthesia was therefore often necessary when dealing with these young infants.

Flesh and Pietri in 1911 did pioneer work in this direction when they attempted to determine the normal stomach of nurslings and children, using bismuth or barium in their feedings. Their findings are mainly based on the results of fluoroscopic examination. Although this method is valuable as an accessory in such a study as ours, it had the great disadvantage of introducing the element of the personal equation, not allowing the findings to be checked up by other observers. As will be indicated below, their findings cannot be substantiated in the light of more modern methods.

The radiographic work was done in the Edward N. Gibbs X-Ray Laboratory (Carnegie Laboratory, New York University) by the director, Dr. L. T. LeWald.

TECHNIC

All the radiographs were made with the subjects in the vertical position. All were taken with the plate at a uniform distance of 24 inches from the anode. The exposures were all instantaneous and taken at the height of inspiration. Markers were placed on the ensiform and umbilicus. The tube was focused on the umbilicus.

Bismuth subcarbonate was mainly used, with the exception that bismuthoxychlorid was employed when an absolutely neutral salt was required. The proportion of bismuth used was approximately 10 gm. of bismuth to the 100 c.c. of feeding. The majority were fed by gavage unless a special experiment relating to the food itself was in progress.

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* Read at the meeting of the American Pediatric Society, Washington, D. C., May, 1913.

It was natural for the early observers to compare their findings with recognized types of adult stomachs which had become, so to speak, standard—such as the Holzknecht type or the Rieder or "J"-shape or fish-hook type, which is the accepted type of adult stomach. The child's stomach approaches it more nearly after the second year. It was found, however, that the form of the stomach depended on the age of the child and the character of the food ingested, but on account of the imperfect apparatus they did not find that the x-ray gave them any help in studying the functionating ability of the stomach.

METHOD OF STUDY PURSUED

Our own study was planned for the purpose of determining if possible (1) the normal size and shape of the infant's stomach; (2) its relation to the neighboring organs; (3) the influence of the internal organs on the viscus; (4) its behavior under differing amounts of food; (5) influence of different types of food as liquid or solid, acid or alkaline; (6) its peristaltic action; (7) the motility; (8) the passage of food through the gastro-intestinal canal; (9) the application of this knowledge to certain pathological conditions.

The age of the infants studied varied from the new-born of 2 days to 20 months. Serial Roentgenograms made this study possible. The reproductions eliminated the personal equation and enabled us to reach certain conclusions.

At first infants were purposely selected at random; later those considered quite normal were studied, and finally those showing pathological conditions, as malnutrition, rickets, syphilis, pyloric obstruction, spasmophilics, tuberculosis, etc. The interval between the administration of the meal and the first exposure was from one to five minutes. Subsequent exposures were made at intervals of ten minutes to twenty-four hours in a given case, depending on the character of the experiment under way. We did not lose sight of the fact that this work was one-sided and that certain elements of error might occur, but we did hope that we could add something to the investigations previously made in physiological laboratories, eliminating the error of test-tube work and interfering as little as possible with the natural processes going on in the infant's stomach.

At this point it may be of interest to state that independently of our efforts and unknown to us, Alwens and Husler of Frankfort were engaged in a problem apparently along similar lines; wherein our findings differ from these observers will be indicated later.

We approached this work with rather fixed ideas as to the natural conformation of the infant's stomach, but these were soon dispelled. Our ideas were those generally accepted, and it may not be amiss to quote from some standard text-books the description of this viscus, as it will

Series A—Figure 1.

Series A—Figure 2.

Fig. 1.—Series A. Baby T., aged 2 days; nursling; 13 drachms fermented milk and bismuth introduced two hours and twenty-five minutes after last nursing. Exposure one minute after administration of food. Note size and shape of stomach and the gas area; a fairly large quantity of food has passed through in this time.

Fig. 2.—Series A. Same infant as in Fig. 1. Exposure after forty minutes. Note contraction of stomach and that large proportion of the food has entered the intestine.

Series B—Figure 3.

Series B—Figure 4

Fig. 3.—Series B. Aged 2 days; breast fed; 15 drachms given two hours and thirty minutes after last nursing. This exposure two minutes after the feeding. Note large size of this new-born stomach, about one-half gas and one-half food; a considerable amount of food has passed through pylorus in two minutes.

Fig. 4.—Series B. Same as Fig. 3. Thirty-seven minutes after feeding; pyloric end still to right side of median line; food throughout jejunum.

Series C—Figure 5.

Series C—Figure 6.

Fig. 5.—Series C. Baby B., male; aged 4 days; nursing baby. Exposure after two minutes; 1¾ ounces food given two hours and forty minutes after last feeding. Note large size and peculiar shape of stomach; greater curvature at the umbilicus; food already extruded into jejunum.

Fig. 6.—Series C. Same infant as in Fig. 5, thirty minutes after feeding; the greater part of the food has passed through into the small intestine; stomach has contracted only slightly. Remarkable decrease in amount in twenty-eight minutes.

Series D—Figure 7.

Series D—Figure 8.

Fig. 7.—Series D. Baby L., aged 4 days; nursling; 15 drachms bismuth mixture about three hours after last breast feeding. Exposure after two minutes. Note large gas area; pars pylorica is visible; some food already in jejunum.

Fig. 8.—Series D. Same infant as in Fig. 7, twenty-three minutes after feeding. Note the transformation in shape to tobacco-pouch form. Stomach almost empty after twenty-three minutes. Food throughout small intestine. Note stream of food pouring out through pylorus.

Series E—Figure 9.

Series E—Figure 10.

Fig. 9.—Series E. Baby P., aged 11 days; nursling; two hours and twenty minutes after nursing 2½ ounces bismuth-milk mixture introduced. Exposure after five minutes. Note amount of food for age and stomach only one-half filled; large gas area; considerable portion of viscus passes to right of median line; greater curvature here well marked and reaches the umbilicus; only traces of food have gone through.

Fig. 10.—Series E. Same as Fig. 9, forty-five minutes after feeding; a peristaltic wave is seen passing over the greater and lesser curvature; the antrum is drawn out spindle-shaped; large deposits of bismuth appear low down in intestine.

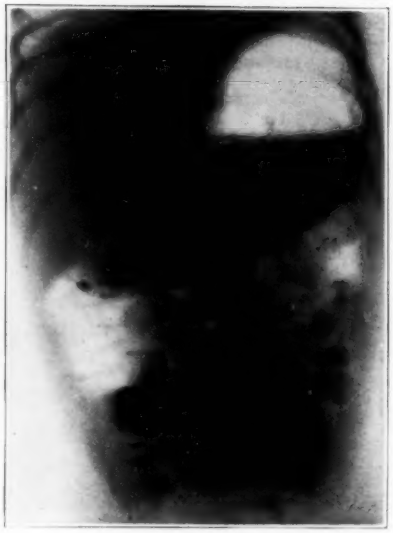
Series F—Figure 11.

Series F—Figure 12.

Fig. 11.—Series F. Baby aged 9 weeks; normal baby; breast fed; complemental feed just begun; 2 ounces bismuth mixture given. Exposure two minutes later. Scotch bag-pipe form; pylorus 4 cm. to right of median line; large amount of gas in cardiac end.

Fig. 12.—Series F. Same as Fig. 11. Twenty-four minutes after feeding; remarkable decrease in amount of food in this interval; food is seen in jejunum.

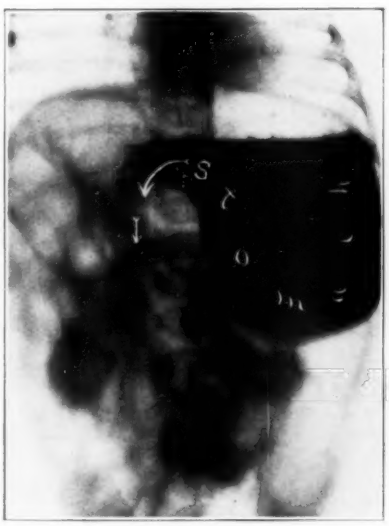
Series G—Figure 13.



Series G—Figure 14.

Fig. 13.—Series G. Baby J. J., aged 2 months; weight 7 pounds; always artificially fed; poorly developed; 45 c.c. bismuth mixture introduced. Exposure after five minutes. Illustrates tobacco-pouch or retort form (a form more apt to occur in weaklings); note amount of food in small intestine; stomach entirely to left of median line; bismuth pouring out.

Fig. 14.—Series G. Same as Fig. 13 after forty minutes; shape has changed from retort form to pear shape; child nursed 22 drachms eagerly twenty minutes after gavage feeding; no admixture of the food has taken place; the gas area increased, probably through sucking action.



Series H—Figure 15.

Series H—Figure 16.

Fig. 15. Series H. H. W., aged 4 months; artificially fed; malnutrition; 125 c.c. bismuth milk mixture; eight minutes later stomach pouch or retort form; pylorus in median line and relaxed; stream of food pouring out. Note amount of food that has escaped in this interval.

Fig. 16.—Series H. Same as Fig. 15 after fifteen minutes; large amount of gas in cardiac pole; the heart pushed upward thereby.

Series I—Figure 17.

Series I—Figure 18.

Fig. 17.—Series I. A. S., aged 5½ months; weight 9 pounds, 14 ounces. Diagnosis: Rickets with enlarged liver and spleen; pulmonary tuberculosis. Took 8 ounces bismuth milk mixture. Exposure five minutes later. Previously fed on a proprietary food; stomach much enlarged; extends well over to right of medium line; the shadow of the liver and tuberculous deposits in the lung are well shown.

Fig. 18.—Series I. Same as Fig. 17 after twenty-five minutes; stomach contracting on its contents. Note change in shape; possibly the precursor of the water-trap type of stomach; extruding large quantity of food.

Series I—Figure 19.

Fig. 19.—Series I. Same as Fig. 18 forty-five minutes later. Conformation entirely changed; only small amount of gas is left; food is seen passing out of pylorus in median line.

Series L—Figure 20.

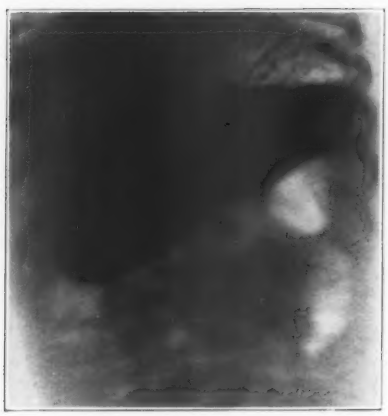
Fig. 20.—Series L. F. L., aged 7 weeks; weight 10 pounds; artificially fed practically from birth; 100 c.c. of bismuth-milk mixture. Exposure after five minutes. Note horizontal position and pyloric end under right lobe of liver.

Series L—Figure 21.

Series L—Figure 22.

Fig. 22.—Series L. Same as Fig. 20. Forty-five minutes after initial feeding the foods have not intermixed.

Fig. 21.—Series L. Same as Fig. 20 after twenty minutes; marked diminution in size; food being forced into intestine; baby now given 3 ounces of its usual formula twenty-five minutes after the feeding by gavage. Note subsequent exposure.



Series X—Figure 23.

Series X—Figure 24.

Fig. 23.—Series X. E. P., aged 3 months; weight 10 pounds, 4 ounces; 100 c.c. top milk, (20 per cent.) + 2 drachms lime-water and bismuth oxychlorid (neutral) used. Example of delayed pyloric opening; one minute after feeding practically no food has passed.

Fig. 24.—Series X. Same as Fig. 23 after twenty minutes; in comparison with other feedings an exceedingly small amount of food has passed through.

Series O—Figure 25.

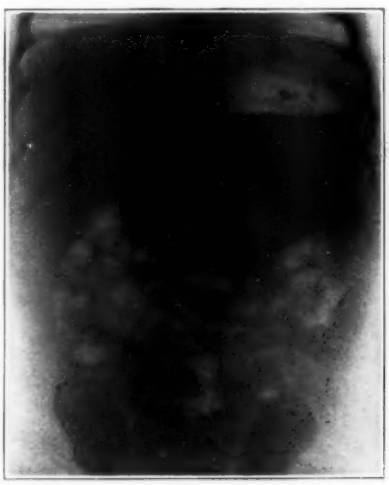
Fig. 25.—Series O. G. M., aged 4 months. Diagnosis: Rickets; spasmophilic infant. Feeding: 6 ounces of 20 per cent. cream, $\frac{1}{2}$ drachm of sodium bicarbonate with 10 per cent. bismuth. Exposure after five minutes. Note horizontal position and large gas area with enormous dilatation of cardiac pole; little food has passed.

Series O—Figure 26.

Series O—Figure 27.

Fig. 26.—Series O. Same as Fig. 25 after fifteen minutes. Amount passed through in this interval decidedly small by comparison.

Fig. 27.—Series O. Same as Fig. 25 after one hour. Change of form accompanied by the exit of some food after an interval of forty-five minutes. Since last exposure, alkalinity apparently has been overcome.



Series P—Figure 28.

Series P—Figure 29.

Fig. 28.—Series P. McC., nursing baby, 2 days old, well nourished; birth-weight 7½ pounds. Exposure made two minutes after having food, consisting of 6 gm. bismuth in 60 c.c. of milk. This is considered to be one of the normal types of infant stomach.

Fig. 29.—Series P. Same as Fig. 28 twenty-eight minutes after original food. Note the amount of food which has passed through the pylorus and how it is scattered through the small intestine. This is considered a normal rate of emptying.

emphasize the importance of checking up the present-day anatomical knowledge with Roentgenograms.

ANATOMY

Cotton, in his text-book on "Diseases in Infancy and Childhood," says of the stomach:

> Contrary to generally accepted statements the general form and position of the stomach are very similar to the empty and collapsed stomach of the adult, but in consequence of the large size of the left lobe of the liver, the whole anterior surface is usually covered by that organ. When the stomach is filled, the movement of its pylorus towards the right side is probably impeded by the large liver, thus tending to make the axis more vertical. The fundus is usually less pronounced and the valvular constriction of the cardiac orifice is wanting, allowing easy regurgitation of the contents. The average capacity at birth is less than an ounce.

In Holt's Diseases of Infancy and Childhood, the description reads thus:

> In the newly-born child it lies somewhat obliquely in the abdomen, and at the end of infancy has almost reached the transverse position. The stomach at birth is nearly cylindrical, but the fundus increases in size rapidly during the first year, although it does not reach its full development until quite late in childhood.

Chapin and Pisek in their book say:

> The stomach is somewhat like a vertical sac at birth, but gradually develops in a horizontal direction.

As a result of our investigations we are forced to the conclusion that there is no definite normal type of stomach in the infant. It is horizontal rather than vertical in position when compared with the adult type, and follows certain rather definite forms. We can distinguish (1) the ovoid, or Scotch bagpipe shape of Flesh and Pietri; (2) the tobacco pouch (or retort shape of Alwens and Husler), as previously described by us; (3) the pear-shaped stomach with base above and to the left. The shape of the stomach does not even depend directly on the amount or character of the food ingested, but rather on the quantity of gas which it contains or acquires. Furthermore, its limits are greater than we were accustomed to believe, extending to the liver on the right and at times filling the entire transverse space from one abdominal wall to the other.

The upper border or smaller curvature may or may not be seen in the Roentgenograms, while the lower border is formed of an indeterminate portion of the viscus.

Of particular interest from the standpoint of diagnosis is the position of the pylorus. In the majority of cases this is found comparatively high and behind the pyloric third; at times its position cannot be determined even though we clearly see that the food and bismuth has passed

out of the viscus. This is especially true in the tobacco pouch form, in which the pylorus is forced posteriorly.

Alwens and Husler report that they have observed a change in form from the tobacco pouch to the bagpipe variety after the intestines have been emptied. This finding also occurred in our series (Figs. 13 and 14). The Rieder type was observed only once, occurring in a six-months old infant (Fig. 18). It appeared first as the bagpipe form, changed to a Rieder and then to a retort form. When semi-solid food is being taken comparatively little gas is swallowed and the stomach is more apt to simulate the adult or Rieder type. The question of contained gas, or introduced gas, is an interesting one. In some cases the gas seems to act as a buffer, preventing the over-distention of the stomach with food. As a rule, the broader or more protuberant the abdomen of the infant, the greater the amount of gas the stomach contains.

PYLORIC ACTION

One of our most noteworthy observations related to the rapid passage of food out of the pylorus—in a number of cases bismuth was seen in the duodenum one minute after the food had been introduced into the stomach by gavage, the average time being five minutes; in one case of the tobacco pouch, or retort form, the action was not unlike that of a siphon (Fig. 15); after the greater part had passed through the pylorus the emptying action became slower. Except in the instances in which semi-solid food (farina and bismuth) or cream were fed, the viscus tended to empty itself with unsuspected remarkable rapidity. How this action can be taken advantage of in cases of pyloric stenosis and pylorospasm has been indicated in a previous article.[1]

We must also question in this connection the advice of those who, like Grulee, recommend placing all infants on four-hour feeding intervals, since a large number of stomachs practically empty themselves within an hour. In abnormal cases, as in infants having chronic disturbances of nutrition the stomach began to empty itself very rapidly, and the emptying time was even shorter. If further proof is necessary as to the rapid emptying of the infant's stomach, it can be found in the fact that infants, to whom it was offered, greedily took their bottles of modified milk thirty to forty-five minutes after the feeding by gavage. This is well illustrated in Series G (Figs. 13 and 14), and also in Series L (Figs. 20, 21 and 22). Roentgenograms of an infant of 7 weeks who took 3 ounces of bottle feeding forty-five minutes after the administration of 3½ ounces of fermented milk and bismuth.

We attempted also to corroborate the suggestive experiments of Cowie and Lyon on the pyloric opening and closing reflex. It was impossible

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to record or obtain Roentgenograms of the action of the pylorus itself which they so well described, because as has been said above, the pylorus and the first part of the duodenum are rarely visible, but the retarding action, for example, of alkalies, which they record, is well shown in Series X (Figs. 23 and 24). Here the stomach did not empty itself for four and one-half hours. Again giving an infant, for example, one type of food, as fermented milk with bismuth, and then allowing it to take its bottle containing modified milk, we were able to verify the work of Cannon and the observations of Grutzer and Sick, who found that foods in the stomach do not tend to intermix. Sick goes even further and says that with fluid food we have the formation of true layers, so that in milk digestion we have the whey expelled first, later the casein and last the fat content.

STOMACH TONE

Observations on the contracting power or tone of the stomach can also be made by this method. The normal stomach tends to expel its gas accumulation soon after the entry of food; it tends to envelop or surround the food, to diminish in size generally, to shorten its axis by drawing upward and to the left partly under the shelter of the diaphragm. This action is not as marked in infants who retain the tobacco-pouch form; here we observe merely a diminution in the size of the viscus.

A peristaltic wave passing along the greater curvature is caught on the plate at times (Series N; Fig. 23). It is more apt to be seen in cases of habitual vomiting or in infants having pyloric stenosis or spasm. We have very seldom observed the wave along the lesser curvature, but this is not remarkable in view of the fact expressed above that the smaller curvature is seldom in sight.

In conclusion it may be said that the field of research in this direction has merely been opened. There are many observations, particularly dealing with the food in the intestines, which need close study, especially in their relation to disturbances of the bowel function so frequent in early life.

How much help we can obtain in our pediatric practice by a Roentgen examination of the alimentary canal in infants and children will be apparent by a study of the statements just made and the illustrations shown.

36 East Sixty-Second Street—338 East Twenty-Sixth Street.

URINARY LITHIASIS IN INFANCY*

ARTHUR N. COLLINS, A.B., M.D.
DULUTH, MINN.

At first thought, urinary stone and especially stone in the kidney is a subject pertaining to adult life. The discovery of the condition, especially of renal stone, in an infant or small child provokes an additional interest and concern owing as well to the tender age of the patient as to its comparative rarity of discovery before death.

Our chief sources of light on this subject are to be sought in the recent reviews, more especially of the German and French. In earlier literature the treatment of the subject has been with reference to older children, including those up to 15 years of age. In some of our modern textbooks, no mention is made of renal stone in infants; in some others, the subject is given scant attention. Stone in the bladder and gravel in the urine occupy places in the literature extending many years back, the treatment by medicinal and dietary measures being placed in the foreground. Until recent years — notably since the advent of the x-ray — little attention was given to the surgical aspect of stone in the infant kidney or ureter, though bladder stones have for generations been treated surgically.

My attention was first attracted to this subject a few years ago as the result of a case in an infant of 16 months which came under my observation. The interest attendant on a study of the literature led me to collect considerable material and in this manner the present paper found its beginnings. As a basis for discussion, the history of the abovementioned case here follows:

CASE REPORT

History.—The infant was a 16-months'-old male, born in Minnesota, of Bohemian parents, neither of whom ever complained of any urinary trouble. The mother's brother, a lad of about 7 years, had been known to pass gravel with the urine in his early days.

The baby had been circumcised at 4 weeks of age, was breast-fed for the first year and suffered none of the usual children's diseases, with the possible exception of "colics," until the onset of the present trouble. Until several months of age, according to a certain custom, the baby was kept wrapped about, arms confined to the sides, by a long scarf or long quilted band allowing of no exercise of the arms or legs, except once daily when the band was removed for a short time.

Examination.—I saw the infant late one December afternoon, 1909. He had not urinated for twenty-four hours. Examination revealed a spherical stone

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* Read in the Section on Diseases of Children of the American Medical Association at the Sixty-Fourth Annual Session, held at Minneapolis, June, 1913.

(Fig. 1 "x") impacted in the extreme end of the urethra. On the extraction of the obstructing stone the baby passed a large teacup-and-a-half of urine. The stone, weighed later, proved to be ¾ grain and by analysis was composed of earthy phosphates. Three months following this onset of trouble the father brought to me several smaller stones which the infant had passed. Radiographic examination was advised to determine if possible the presence of other stones in the urinary tract. After a delay of three months the parents brought the patient for such an examination. The result of such examination, six months after the onset, shows (Fig. 2) two stones in the right kidney, one in the bladder, and a third somewhat irregular shadow appearing at about the crest of the right ilium — probably ureteral stone. Radiographs a few days later substantiated the findings at the first sitting. Surgical interference was positively refused by the parents.

Plates taken about nine months after the first radiographs revealed the calculi as before (Fig. 3) but with some destruction of kidney substance. In addition, shadows in the region of the left kidney appeared, showing the formation of calculi in that organ. The infant continued to pass small calculi at intervals. About a year later the child was operated on in Chicago for bladder stone.

At the present writing I am in receipt of a personal communication from the father to the effect that the child is in fair health — at the age of 4½ years — though no relief has been attempted for the kidney stones. The same letter

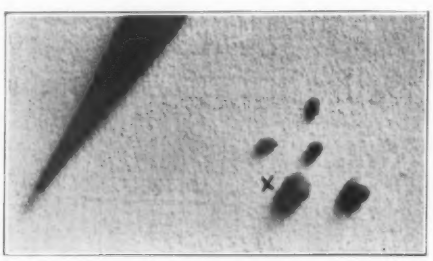

Fig. 1.—Showing spherical stone "x," which was removed from child's urethra. The other stones were passed by the child at varying intervals.

also conveys the information that the child's uncle (the mother's younger brother, above referred to in the history) is just recovering from an operation for bladder stone "the size of a pigeon's egg." He was 10 when operated on, and my letter states that he had passed fine gravel which was first noticed when he was 3 months old and has done so at intervals since that time. During the last two years his condition has been very much worse.

The family history of stone in this case is of interest. As an example of extensive family occurrence it is interesting to note the experience of Clubbe, who operated on the three sons of a fisherman of Lowestoft, England, for stone, at ages of 2, 3 and 8. The father and mother always had gravel in the urine. The grandfather passed one and the grandmother passed seven stones. A great uncle was operated on for stone. Six uncles and four aunts all suffered from spells of gravel, and finally a cousin, an uncle's child, was accustomed to pass gravel.

Too much stress should not be laid on the family tendency, however. The experience of Clubbe is rather to be regarded as rare than common.

In Bokay's experience he has seen only one case in which he could lay any stress on heredity in the sense of families of stone formation.

Other cases of urinary stone are quoted by various authors as having

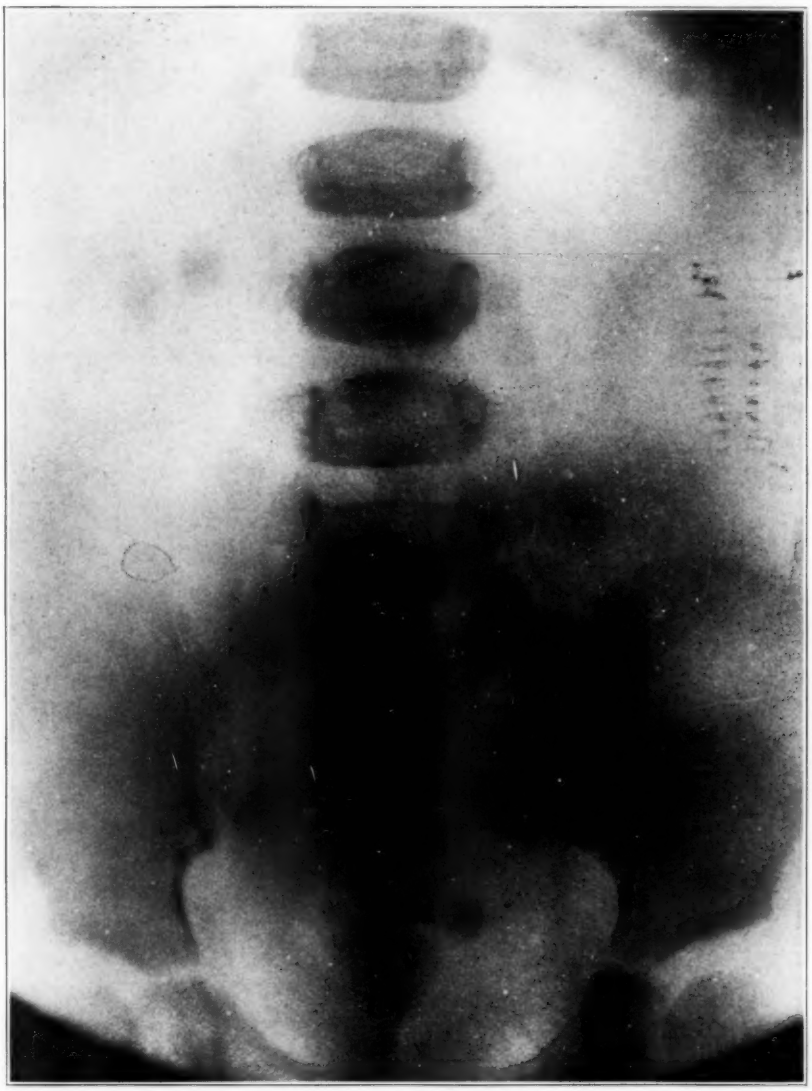

Fig. 2.—Radiograph showing two calculi in right kidney, one in the bladder and a third shadow at the crest of the right ilium — probably stone in the ureter.

been found early in infancy or even before term. Langenbeck found a calculus in the bladder of a six-months fetus. Southworth, in 1895, presented the New York Pathological Society with the kidney of a new-

born child containing calculi. Brendel quotes three cases two days after birth. Meigs records the recovery of a calculus post-mortem from the kidney of an infant of 6 months. Two cases of renal stone discovered in infants of 20 months are recorded by Hance and Partridge. The latter's case presented no symptoms of calculus during life. It was discovered at

Fig. 3.—Radiograph, taken nine months after that shown in Fig. 2, showing two calculi in right kidney and destruction of kidney substance. Also the bladder stone as in Fig. 2. In addition, two shadows are shown in the left kidney region.

autopsy. Jacobson cites a case of a child operated on in which the bladder was found to be in a condition of complete incrustation. At autopsy both kidneys were found to be absolutely filled with stone. G. Newton Pitt records three cases of renal stone in infants, discovered at autopsy. The first was in an infant of 15 months. Death occurred

from diphtheria. A stone weighing 4 grains was found at autopsy. The second was 11 months old when death occurred from diphtheria. The kidney stone in this case weighed 2 grains. The third infant was 21 months old when death occurred from bronchopneumonia. Hematuria had been noticed during life in this case. The stone recovered at autopsy weighed also about 2 grains.

OCCURRENCE

Civiale found that 45 per cent. of 5,900 cases of calculus occurred in children, and that children under 5 years are especially prone to the condition. The principle of "survival of the fittest" holds its sway with remarkable tenacity respecting urinary stone. A high percentage of the known cases appear to be those discovered at autopsy. It will be seen by referring to Tables 1 and 2 that of the patients under 5 years, about 92 per cent. are 2 years or under, and that practically all of these are cases which have reached the autopsy table. In the past, therefore, it would seem that urinary lithiasis, especially of the renal type, laid just claim to a high mortality.

Holt, basing his information on 1,000 autopsies, says that small renal calculi are very common in infants, but that they are probably voided during the first two years of life because of the fluid diet of the first two years.

While it is possible that the fluid diet may influence favorably some cases, it is also possible that the fluid diet may in some cases be largely responsible for the condition of urinary lithiasis. As an instance let me quote Robin's goat-milk case: An infant of 16 months was raised on goat's milk. The infant passed uric acid gravel. Analysis of the milk showed excess of casein. Excess of azote or nitrogenous food was found to be the prevailing diet of the goat. The food of the goat was thereon changed, and very promptly the infant's nephritic colics disappeared.

Charvin and several others are inclined to the belief that renal stone in infants and children is a rare condition. Rafin, who collected 39 cases in infants and children either operated on or revealed at autopsy, says: "The small number of cases attests to the rarity of the surgical form of renal and ureteral calculus during infancy," and he then raises the question as to whether this is a real rarity.

Durand-Fardel and Civiale believe nephritic colic in the infant is not a rarity. Gibbons reports six cases in infants of 9 to 23 months. Bokay has collected in Hungary some 1,836 cases of urinary stone in infants and children of ages ranging as high as 15. Of these, 45 were 12 months of age or under, as follows:

Age Months	Cases
2½	1
3	1
5	3
6	6
8	4
9	4
12	26

The bladder stone cases numbered 1,319; one-half the cases were urethral and nine of the cases were of kidney stones. The greater number of cases occurred at 3 to 4 years.

The literature is far from being replete with cases of renal stone discovered and treated, whether successfully or unsuccessfully, during life.

How important in the mortality statistics from birth to 2 or possibly 5 years is the factor of the stone or stones *per se*? How many of the bladder or kidney stones forcing themselves into recognition in later life might be discovered in infancy or childhood? These questions will be taken up later in the course of this paper.

According to Senator it is impossible to make a hard and fast morphological distinction between renal and vesical calculi. Carl Beck believes most vesicle stones come from the kidney. Porter says nephritic calculi are not relatively so rare very early in life as are vesicle calculi.

Certain it is that many of the calculi do not produce any morbid phenomena until they reach the bladder. Moreover, there are numerous instances on record to show that definite and very troublesome cases of stone discovered in young adult life had their origin during infancy or childhood. I have called attention above to the relative of my little patient who was operated on about nine years after gravel was first noticed in his urine. The cases quoted by Monsseaux and Charvin which are arranged in Table 3 are illustrative of this fact also.

The endemic, hereditary, dietary and systemic phases in the occurrence of urinary stone are ably reviewed by Hugh Young in Osler's Modern Medicine and will not be dwelt on here. It is a significant fact, however, that the children of the poor are more prone to harbor urinary stone than those of the rich. Von Preindlsberger, in reviewing his 271 cases about Bosnien-Herzegovina, claims that lithiasis is far more prevalent in the Christian population than in the Jewish, most likely by reason of the unfavorable conditions essential to living and the bad prevailing diet of the Christian children.

It is an established fact that males are subject to lithiasis far more often than are females. In the statistics given in Table 1 the males outnumber the females 2 to 1. Bokay's statistics show that only 4 per cent. were girls. Coulson's comparison places the figure at 5 per cent.

Rafin finds urinary stone occurs most frequently on the right side. While we have here in America no regions where lithiasis is essentially endemic, as in Egypt or in Asia, still the condition is known to be fairly evenly distributed over the different parts of this country.

TABLE 1.—SHOWING RECORDED CASES, THE RELATIVE AGES AND SEX PROPORTION AND THE PROPORTION OF AUTOPSY CASES*

Name	Total Cases	Cases at Autopsy	Under 1 Year	1 to 5 Years	Male	Female	Not Stated
Rafin	39	28	0	5	24	11	4
Pitt	3	3	3	....	....	....	3
Charvin	45	10	0	....	....	....	?
Jacobson ...	1	1	0	....	....	....	1
Hance	1	1	1	....	....	....	1
Partridge ...	1	1	1	....	....	1	....
Meigs	1	1	1	....	....	....	1
Langenbeck..	1	1	1	....	....	....	1
Brendel	3	3	3	....	....	....	3
Clubbe	2	0	0	2	2	....	....
Southworth..	1	1	1	....	....	....	1
Aleksinski...	1	0	0	....	1	....	....
Jopson	2	1	0	2	2	....	....
Smythe	4	0	0	4	....	....	4
Sumpter	1	0	0	1	1	....	....
Porter	1	0	0	1	....	1	....
Monsseaux...	77	?	0	9	51	26	....
Comby	48	48	46	2	31	17	....
Joseph	40	40	38	2	27	13	....
Bokay	45	?	45	....	....	....	45
Mandble	1	?	0	1	1	....	....
Dun	1	?	0	....	....	....	1
Jaffrey	1	?	0	....	....	1	....
Drew	1	?	0	1	....	....	1
Nash	1	?	0	1	....	....	1
Totals ...	322	139	140	26	140	70	67

* The males outnumber the females 2 to 1. Of the total number of 322 cases, 139, or over 43 per cent., are post-mortem cases.

ETIOLOGY

The etiology of urinary stone has furnished a subject for much discussion in past times. Heretofore divers theories have been advanced to explain the existence of such calculi. A traditional view holds that the mode of life, diet, and especially nitrogenous diet with wine, beer and little exercise, is conducive to stone. Again, any interference with urinary discharge is regarded as a predisposing factor. English believes a congenital narrowness of the urethra in the second year is a factor in vesicle

calculus in boys. Langstein states that in addition to uric acid infarction, endemic conditions have a decided influence on the formation of a calculus; also, that heredity, especially from gouty parents, and still further, the amount of calcium in the drinking water, are important factors. Phosphatic medication was supposed to have an influence in the occurrence of a stone in an infant case reported by Anozan. Comby states that the cause of stone formation is poor alimentation and inanition.

TABLE 2.—To Show the Age Distribution of Cases of Renal Calculus in Infants and Children Five Years and Under in One Hundred Seven Cases*

Name	Under 3 Mos.	3 to 6 Months	6 to 12 Months	12 to 24 Months	2 to 3 Years	3 to 4 Years	4 to 5 Years
Comby	11	17	18	2	....	....	....
Pitt	0	0	1	2	....	....	....
Monsseaux...	0	0	1	2	3	2	1
Mandble	0	0	0	0	0	1	....
Joseph	12	15	11	2	....	....	....
Drew	0	0	0	0	0	0	1
Nash	0	0	0	0	0	0	1
Southworth..	1	....	....	....	....	....	....
Meigs	0	0	1	....	....	....	....
Partridge ...	0	0	0	1	....	....	....
Hance	0	0	0	1	....	....	....
Totals	24	32	32	10	3	3	3

* From the above table it will be seen that ninety-eight cases or 91.5 per cent. of the total, are 2 years or under. It will also be found by comparing with Table 1 that practically all of the 91.5 per cent. are post-mortem cases.

The influence of the infectious diseases on urinary lithiasis cannot be ignored. M. Nove-Josserand is quoted by Rafin as having recorded a case of renal stone discovered by the radiograph and recovered at operation in a child who first had a mouth infection followed by bronchopneumonia and later by a grave osteomyelitis. The renal symptoms appeared at the close of the above series of complaints. He quotes, also, Eynard's case, in which the stone was perhaps the result of a grave impetigo. The association of various infectious diseases with urinary stone is also pointed out in connection with Joseph's cases, as seen in Table 4.

Albarran's classification of renal stones into *primary* and *secondary* stone has been widely used, and is utilized by Charvin in his study of forty-five cases in infants and children. The first form (primary) is considered to be due to or at least associated with gastro-intestinal dis-

orders, deficient alimentation or poor elimination. The second form (secondary) is considered to be due to bacterial activity, chemical modification of urinary constituents and precipitation of urinary salts. The primary is believed to occur in the very young and the secondary in older children, or to put it in another way, the secondary form does not occur in the very young infant.

On this problem of the origin of primary renal calculi, Schade furnishes an explanation based on certain scientific facts. To quote Robert Milne's summary of Schade's work:

> We must comprehend what he means by the terms "colloids," "reversible" and "adsorption," as applied to this problem. "Colloids" are substances which appear to dissolve in water (e. g., mucin or fibrinogen), but are probably in a condition of suspension, since the osmotic pressure is not affected by their presence. A "reversible" substance is one which can be redissolved after being deposited from solution, for example, a crystal of magnesium sulphate. Mucin is a reversible colloid. Fibrin is an irreversible colloid. Adsorption is the property colloids have of holding in a solution inorganic substances to an extent greater than could be dissolved in an equal quantity of water. He would suggest that, for example, uric acid in urine is held there in its excess by adsorption, on urochrome and other reversible colloids.
>
> Should the uric acid be in excess of the amount which the colloid can hold by adsorption, we can picture the uric acid being deposited on the colloid. Should the colloid be a reversible one, both colloid and deposit can be removed by more water. If the colloid be irreversible, e. g., if that uric acid be deposited on the surface of fibrin, then no amount of water will redissolve that irreversible colloid — the patient is forming a primary renal calculus which no mineral water or drug ever cured. The colloid is the source of the small amount of organic matter found in every primary aseptic calculus. The tendency of fibrin to form laminae is the reason of the laminations of these primary renal calculi, and lastly, to cure that patient we have only to diet him in the future to prevent excess of the substances which formed the stone; we have not only to tell him to prevent relative excess by drinking abundance of water, but we have to discover the cause of fibrinuria, or fibrin in the urine, which occurs apart from hemorrhage. This problem has still to be solved.

Joseph describes, in connection with his study of forty autopsy cases, a peculiar albuminous substance which he found beneath the kidney capsule and also in the Bowman's capsule, morphologically glairy and homogeneous, sometimes occurring in lumps and appearing like fibrin, much the same as the hyaline casts in the urine. He concludes that calculi are caused by renal changes. He observed in kidneys containing stones, changes which were the same as those in the opposite kidneys without stones.

It would be difficult to believe that infection plays any considerable part in the origin of stone during uterine life or in the very young infant. Morris states that the nucleus of calculi formed in infancy is generally urate of ammonium.

SYMPTOMATOLOGY

To await classical symptoms of calculus as may be encountered in the adult is to waste valuable time. Calculus may exist in the kidney without

giving rise to symptoms of any kind. Beck found that whenever there was a calculus in the bladder he found a renal calculus also. There may be serious paroxysms of pain which are the result of the incarceration of stone. Hematuria is not always to be expected, however, when stone is present. Pitt reports a case of stone found at autopsy in an infant of 15 months, in which case no blood had ever appeared on the napkin. The possibility of microscopic blood is to be considered here. The history merely states that the infant passed more water than the other babies in the family.

In the observation of Monsseaux, who reports some seventy-seven cases, hematuria was a sign in but eight of the cases. He mentions a hereditary disposition in forty-four of the cases. According to Durand and Civiale, nephritic colic is not a rarity. Small children are not, however, capable of indicating the site or the character of the pain. The older the child the less difficulty will usually be found. From the sudden onset of pain the child is apt to cry continuously, and while the pain may at first be in the region of one kidney or the other, later in the attack the pain is usually diffused over the abdomen. Nausea and vomiting may occur with greater or less frequency and present a bilious character. The absence of diarrhea will, however, be noted to remove suspicion from a possible essential gastro-intestinal disorder. The face is pale, and, in the words of Monsseaux, "the expression vividly reflects the pain in the suffering infant." After a few hours the crying and restlessness may cease and more or less small gravel may be found in the urine. Or the picture may be that presented by my case in which the first alarm was sounded by a suppression of urine due to an impacted urethral stone, the finding of which led to the suspicion of other stones in the urinary tract. Blood may be found only on microscopic examination. The tendency to a remission of the symptoms renders the condition very chronic in its course.

Mention is made of an occasional case in which urinary stone is associated with disturbances of the nervous system. Monsseaux cites one case in which injury to the head at the age of 6 months was followed by gravel in the urine. Aleksinski's case, having "nervous fits" at 2 years, which will be quoted further on, has also a suggestion of this nature in it.

DIAGNOSIS

An analysis of the urine cannot always be relied on to give specific information leading to the diagnosis of urinary stone, though the urine findings are often suggestive. Microscopic examination of the sediment in a suspected case may disclose blood or pus cells, or crystals of oxalate, phosphate or of uric acid. The urinalysis may, however, present certain constant characters in that the urine may be somewhat abundant, the

specific gravity 1.023, 1.025 or 1.030, the acidity often considerable and a fine precipitate of flakes of uric acid crystals, brilliant and orange colored, to be found, the uric acid being greater than normal.

The history of elimination of sand is an important matter to determine, if possible; also, the history of frequent or painful micturition should be recognized as suspicious of stone. Hematuria accompanies nephritic colic, especially with oxalic gravel, less frequently in the interval between crises of colic. Hematuria of bladder origin is thought by Monsseaux to be very rare in the infant.

Palpation of the kidney, ureter and bladder regions may not reveal the site of trouble until late in the attack. It should therefore be tried again. Eliot reports a case in which the kidney was very much hypertrophied, but was misplaced by an accumulation of gravel (presumably in the kidney-pelvis). Murphy's "first-percussion," in a modified form, may be used over the kidney regions at the back, by employing, instead of the fist as a pleximeter, fairly vigorous percussion with one or two fingers of the right (or striking) hand. This method may serve to differentiate between involvement of the right or left kidney early in the attack.

Differentiation must at times be made from affections of the liver (rare in the infant); also lumbago (rare), Pott's disease and appendicitis. In a case of Weill's, the latter was clearly to be considered in the diagnosis. Nephritis is not rare in the infant. Casts should be searched for. Renal tuberculosis in the infant generally runs an acute course. Other organs are involved. Cancer in infants or young children is not accompanied by renal or ureteral pain. Renal tumefaction should be sought and an examination made for symptomatic varicocele, "always pathognomonic to that age," according to Charvin.

Abdominal pain of a spasmodic character accompanied by vomiting, but without diarrhea, the maximum pain traceable to the kidney or along the ureter, dysuria, rapid recovery from the attack and that followed by passing gravel, leaves little else to complete the diagnosis. In infected calculus, pus and very little blood may overshadow symptoms of its presence.

Rectal examination may be useful in the diagnosis of bladder stone, also ureteral stone. Fagge and Robinson are each quoted by Rafin as having made diagnoses of calculus in the ureter by this method.

Ureteral catheterization in the infant is practically impossible. It is difficult to say at what age such instrumental procedures begin to be practicable. Rafin separated the urine in a little girl of 6 months.

If the radiograph is important as an agent in diagnosis on the adult, it is of even greater importance in the diagnostic endeavor on the infant. Here it has served to point out many errors which occurred in diagnosis

before, and it should be advised in all suspected cases. Hartman speaks of a case in which a radiograph was not made and the surprise was great at finding stone at autopsy. In our day the diagnosis should not be considered complete without a good radiograph. It may not always be complete with the radiograph. It is said by Tenney that a positive plate is more dependable, however, than a negative one, although there is a small degree of error in both negative and positive. In ninety-three of Leonard's cases, five failed to find stone. In 233 of his cases with negative diagnoses, a stone was found at operation, or passed, in four. Carl Beck advises radiographing the kidney region in addition to the vesical when vesical calculus is suspected. It is very desirable that a radiograph be obtained which shows clearly all kidney, ureteral and bladder regions, i. e., the total urinary system. In infants and young children two plates should be sufficient and usually one large plate will suffice. In case two are used, one should show both kidney and upper ureteral regions, the other should include the bladder and lower ureteral regions. The necessity of an instantaneous exposure in the case of a crying and wriggling infant needs no elaboration. Immobility of respiration is practically impossible. The dorsal position is found to be the best. The thighs should be flexed, even to a right angle, if necessary, in order to eliminate the "saddle-back" and to permit contact of the back with the plate. A purge is advisable before the radiograph is made. The table should be warm to lessen trembling.

The knowledge of the localization of stones simultaneously in different parts of the urinary tract is very important. A direct relationship exists between the multiplicity of localization and gravity of operation. Multiplicity of localization also darkens the prognosis.

PROGNOSIS

Charvin states that lithiasis in the adult may be traced back to infancy. This would lead one to believe that the immediate prognosis is good. Gravel, it is true, is generally of long duration. (See Table 3.)

In Table 3 it will be seen that the interval of time between the date of onset, or at which symptoms pointing to disturbances in the urinary tract occurred, and the date of admission, or such time as the patient presented himself for treatment, varies within wide limits. In the thirty-eight cases tabulated it will be seen that the interval above mentioned ranged from six months or less up to forty-one years. This is in evidence of the tendency to chronicity with respect to urinary stone. And here we return to the principle of "survival of the fittest." H. Joseph has made a very praiseworthy study of forty cases *post mortem*, in which stones were found in the kidneys or elsewhere in the urinary tract. None of these were diagnosed during life. Of this material, 65 per cent. were

TABLE 3.—To Show in the Cases of Charvin, Monsseaux and Porter the Interval of Time Between First Onset and Time of Admission; Also, Where Stated, Size of Stone Recovered

Case	Age on Admission, Years	Age at Onset, Years	Interval, Years	Remarks
Charvin				
4	3½	?	?	Autopsy: Right kidney crammed with small stones. Largest were 12 x 8 mm. (½" x 3/10").
9	10	8	2	Urate calculi.
11	15	14	1	Stone size small pea.
12	12	9	3	
13	6	3	3	Stone wt. 8 gm.
16	10	?	...	¾" x ¼"; cylindrical.
17	9	4	5	
18	6	¾	5	
19	11	9	2	Stone 8 x 6 x 4 cm. in size.
20	10	2	8	
21	12	11–12	½	
22	5	4½	½	
29	7	4	3	
32	14	12	2	
35	4	4	0	
37	15	15	0	
39	4	3	1	Stone wt. 33 gm.
40	7	?	?	Stone wt. 18 gm.
41	11½	1	10	
42	11½	3	8	
43	9	6	3	
Adult Cases				
46	16	10	6	Stone wt. 25 gm.
47	18	12	6	
48	19	15	4	
49	19	7	12	
50	20	12	8	
51	24	4	20	
52	24	6	18	
53	46	5	41	
Monsseaux				
1	19	5	14	
2	21	12	9	
3	31	10	21	
4	33	15	18	
5	24	12	12	
6	29	7	22	
7	43	8	35	
8	48	13	35	
Porter Case				
..	4	½	3½	Stone wt. 3.9 gm.; size ⅞" x ⅜".

bilateral cases. I have arranged some of his statistics in tabular form, as will be shown in Table 4.

The evident predominance of bilateral involvement, as shown by Table 4, bears out Rafin and Charvin in that the prognosis becomes more somber with multiplicity of involvement. On 76 observations at autopsy Legeu found thirty-six (nearly 50 per cent.) cases of bilateral calculi. Kuster, who bases his study on clinical facts, arrives at the proportion of 11.78 per cent. bilateral stones. Leroy found 22 per cent. of bilateral renal or ureteral stones. Of the cases operated on by Rafin he found four bilateral cases, or 8.8 per cent. A highly important lesson to be drawn from the preceding information, therefore, considering the high mortality of cases of multiple involvement, is that the cases must be discovered and treated earlier, before destruction of kidney substance progresses to cripple the organ or infection becomes a complication.

Cuturi determined from his animal experiments three very potent conclusions: (1) *B. coli* reaching the healthy kidney by way of the bloodstream causes no lesion. It simply causes bacteriuria. (2) *B. coli* in the kidney complicated by calculus provokes pyelonephritis and pyonephrosis. (3) Experimentally, by separation or ligation of the rectum for twenty-four hours, one obtains a pyelonephritis by the passage of *B. coli* to the kidney by way of the blood, after ligation of the ureter. If, therefore, the above conclusions apply to the human, an individual harboring a primary stone runs a greater chance of secondary infection when constipation exists.

When, after much trouble, the kidney ceases the struggle and there occurs a complete disappearance of symptoms, the relief affords a sense of false security, for in the words of Rafin: *"Ce silence sera le signe de la mort de l'organe"* — the silence will be the sign of the death of the organ.

Ureteral stone as well may occasionally take on a serious aspect if it becomes incarcerated. Guisy reports the case of a little girl of 12 in whom a mixed urate and phosphate stone became lodged in the ureter and caused a lumbar abscess, necessitating incision and removal of the stone.

A large number of Monsseaux's patients, many of them older children, were subjects of migraine headache, eczema, epistaxis and conjunctivitis; some were asthmatic, some had urticaria at intervals, others had transient articular manifestations without fever or swelling, but some pain. In his opinion, if the infant is without hereditary taint, the calculus of an accidental sort, due to alimentary disorders and poor hygiene, etc., the prognosis is not too severe and the patient's chances are good under better conditions. If, on the contrary, the infant is an inveterate arthritic subject, with bad heredity, presenting at the same

TABLE 4.—Compiled from Joseph's Forty Autopsy Cases in Infants Two Years or Under, to Show the Relative Frequency with Which Urinary Stone and Complicating Hydronephrosis are Associated with Intercurrent Diseases in Other Regions of the Body

Post-Mortem Findings	Nephrolithiasis			Hydronephrosis				
	Left Kidney	Right Kidney	Bilat.	Left	Right	Bilat.	Bladder Stone	Totals
Atrophy	1	2	2	1	...	...	...	6
Tracheitis	...	....	1	....	...	...	...	1
Enteritis	2	4	8	2	1	...	...	17
Otitis media	1	1	2	....	...	...	2	6
Gastro-enteritis	...	....	2	....	...	...	...	2
Abscess submax. gland	...	....	1	1	...	...	...	2
Cardiac dilatation	1	1	4	1	...	...	...	7
Bronchitis	1	....	1	1	...	...	...	3
Edema pia mater	...	....	1	....	...	...	...	1
Hyper. mes. lymph-nodes	...	1	3	....	...	1	...	5
Rachitis	...	2	4	....	...	...	...	6
Hemorr. pia mater	...	....	1	....	...	...	...	1
Hydrothorax	...	1	....	....	1	...	...	2
Lobar pneumonia	...	2	5	1	1	...	...	9
Ascites	...	1	....	....	1	...	...	2
Bronchopneumonia	1	2	7	....	...	1	...	11
Meningitis	...	....	2	....	...	...	...	2
Hydrocephalus	...	2	2	1	...	...	...	5
Colitis	...	1	2	1	...	...	...	4
Cystitis	...	....	1	....	...	...	...	1
Abscess mult. cutaneous	...	....	1	....	...	...	...	1
Osteochondritis	...	....	1	....	...	...	...	1
Miliary tuberculosis	...	....	1	....	...	...	...	1
Intestinal tuberculosis	...	....	1	....	...	...	...	1
Pulmonary tuberculosis	1	....	1	....	...	...	1	3
Meningeal hemorrhage	...	1	1	....	...	...	...	2
Diphtheria	...	1	1	....	...	...	...	2
Carbuncle and furunculosis	1	....	1	....	...	...	...	2
Pararectal abscess	...	....	1	....	...	...	...	1
Totals	9	22	58	9	4	2	3	107

It will be seen from this table that diseases of an infectious nature occur in association with calculus and hydronephrosis 70 times out of 107, or 65 per cent. Enteritis and gastro-enteritis are associated with urinary stone and hydronephrosis 19 times; rachitis 6 times; lobar and bronchopneumonia 20 times.

Respiratory tract associated with stone or hydronephrosis 29 times.
Alimentary tract associated with stone or hydronephrosis 25 times.
Systemic diseases associated with stone or hydronephrosis 15 times.
Nervous system associated with stone or hydronephrosis 11 times.
Glandular system associated with stone or hydronephrosis 7 times.

time habitual manifestations of the diathesis, is subject to migraines, epistaxis, gastro-intestinal trouble or joint-pains, tends to obesity, in a word, is not uremic or arthritic on occasion, but by temperament, and is rebellious to treatment and subject to recurrences, the outlook is not so good.

TREATMENT

One is confronted in the older literature with the various methods of dietary and medical treatment. In the more recent literature the surgical treatment of urinary stone finds more frequent discussion. Unless the calculi are discovered earlier and removed promptly the mortality will remain high. Calculi in the infant kidney or ureter should be expelled or relieved surgically. The destruction of kidney substance, the blocking of a ureter, the danger of infection, are matters for grave consideration when a calculus is the impeding object. Delay, as suggested by Charvin, enhances the operative risk in that nephrectomy may be necessary in the late stage, where nephrotomy would have sufficed in the early stage. Statistics favor operative relief. Jeanbrau believes the danger of the presence of stone in infants is greater than surgical interference. Sumpter reports a case of bladder calculus in a boy baby 22 months old, removed suprapubically with good result and no recurrence. Porter reports the case of a baby girl first seen at the age of 6 months. She had had colic for two years or more, passing fully a drachm of calculi of small size. Operation was done at 3 years 10 months, and a 60-gram calculus recovered suprapubically. Good recovery followed.

The very instructive case recorded by Aleksinski is worthy of citation here:

> The boy was first seen at 7 years, his complaint being painful micturition. At two he had "nervous fits" which were never accurately diagnosed; at five pleurisy with effusion; at 6 he began to have painful micturition, a thin stream and frequently interrupted. The urine contained pus and blood. The temperature ran as high as 104 F. A diagnosis of vesical calculus was followed by suprapubic removal of the stone. A month later his old symptoms reappeared. Urine 1.007, daily quantity 1,500 c.c., acid, turbid, pus and blood cells, oxalates and mucus. Albumin present. Bacteriological examination showed *B. coli*. Radiograph showed shadows in both kidney regions. Nephrectomy on the right side brought forth three stones the size of walnuts. The urine presented no improvement and three weeks afterward at operation the left kidney yielded four stones. Following this last operation he sat up on the eighth day and was discharged on the seventeenth day. Seven months afterward he was well and the urine was normal.

As in the case just cited, where extensive involvement exists it is an accredited procedure to operate in successive stages. Attention to the bladder stones with neglect of the kidney condition is generally a grave injustice to the patient. The wisdom of finding out beforehand, if possible, the localization of stones simultaneously in different parts of

the urinary tract is therefore very important. In eleven operations done by Rafin on infants and children, five were for aseptic stone; six infected. Two had multiple operations. Ten were nephrotomies. Three were nephrectomies. A pyelotomy was done in one case. Recovery occurred in all of the cases.

Such information as it is possible to obtain by means of the cystoscope and the ureteral catheter in adult cases is seldom if ever possible in the child or infant, and this augments the responsibility of doing a nephrectomy. When dealing with the adult, part of the responsibility is shared by the cystoscopist, who has decided before operation, the adequacy of the other kidney. With the infant or small child the weight of responsibility of removing a diseased kidney rests almost entirely on the operator. Examination of both kidneys through lumbar incisions before deciding the operative procedure may save an occasional fatality.

CONCLUSIONS

1. In the past, urinary lithiasis, especially renal, has been accompanied by a high mortality.

2. Of the cases of renal calculus in children 5 years or under, more than 90 per cent. were 2 years or under, and practically all of those were *post mortem* cases.

3. There is a paucity of case reports of renal stone in infants discovered and treated surgically during life.

4. Calculi discovered in older children or in adult life frequently originate in infancy or childhood.

5. The finding of sand or gravel in the infant urine is sufficient reason for advising radiographic examination of the urinary tract.

6. Gravel may be of long duration, ranging from six months or less up to forty-one years.

7. Diseases of an infectious nature occur in association with calculus and hydronephrosis 70 times out of 107, or 65 per cent.

8. Diseases of the respiratory tract are associated with urinary stone or hydronephrosis most often.

9. Bilateral or multiple calculi in the urinary tract offers a condition with an unfavorable prognosis.

10. To better the prognosis, cases must be discovered and patients treated earlier, before destruction of kidney substance progresses to cripple the organ, or infection becomes a complication.

11. Surgical interference is an accredited procedure. When multiple involvement exists, operation in successive stages may be done.

12. Greater responsibility is attached to nephrectomy in the infant by reason of the difficulty of ascertaining the functional capacity of the opposite kidney.

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THE GASTRIC SECRETION OF INFANTS AT BIRTH*

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There has been no lack of investigation of the gastric secretion of infants. Shortly after the stomach tube was devised by Kussmaul it was carried into the field of pediatrics, first for therapeutic measures and considerably later for physiologic studies. In spite of many years of varied work in this field, it must be admitted that we have not progressed far in our knowledge of the physiology of gastric digestion. Numerous causes may be assigned for this slow progress. One of the main obstacles to a scientific study of secretion — the phenomenon which interests us particularly at this time — has been and remains the fact that the acid juice rapidly enters into combination with the milk food, so that it becomes impossible to judge accurately of its quantity or of its quality. It is this variable factor which accounts for the wide discrepancies in the reports on this subject, for the differences of opinion regarding the importance of hydrochloric acid at this time of life, and for the total lack of normal values for the gastric secretion of infants.

The present study, which was carried out in conjunction with an investigation of icterus neonatorum and its relation to bile secretion,[1] *concerns itself merely with infants during the first few hours of life, who have never been given any food.* Thus the disturbing and complicating factor of the interaction of the gastric juice and of the food does not have to be considered. Quite apart from the question of whether a study from this limited point of view might prove of clinical value, it seemed worthy of investigation for its physiologic interest, because, as we have said, from its very nature it eliminated the food factor and reduced a complex subject to its simplest terms. The questions of suitability of diet, of previous gastric derangement, or of intercurrent illness, in fact, all complicating factors, excepting those possibly congenital in origin, were also naturally excluded.

Our study includes a gastric examination of fifty-five infants, varying in age from one-half hour to eighteen hours. Such a considerable number of tests must not be regarded as indicating a lack of uniformity in the results. They were carried out to this extent because, as has been

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mentioned, this work was performed in conjunction with another experimental study — that of the duodenal contents of the new-born. Indeed, attention was first directed to this question in the course of investigations by means of the duodenal catheter.

A review of the literature of the gastric secretion of infants revealed practically nothing on this phase of the subject. The only published account of examinations of the contents of the stomach of new-born (unfed) infants are two by Leo,[2] and a solitary test made by Szydlowski[3] many years ago. Some post mortem reports were found: Zweifel,[4] in 1874, demonstrated the presence of pepsin in the gastric mucosa of the new-born, and Langendorff,[5] a few years later, found this ferment in the mucous membrane of a 4-months-old fetus.

As the subject seemed worthy of further and closer investigation, it was entered on in detail to determine the presence of free hydrochloric acid, of pepsin, of rennin, of gastric lipase; the degree of secretion and its duration; its relation to the general physical condition of the infant; the relation of the hydrochloric acid secretion to tonicity of the pylorus; its relation to the pancreatic secretions; its relation to later gastric secretion, at a period when the babies had been fed. Finally an attempt was made to interpret the nature of the secretory stimulus in the light of our own tests and of present physiologic viewpoints.

We have summarized the results in tabular form (Table 1). A glance at this table shows that in almost every test hydrochloric acid was found; it was lacking in only one out of 52, and was found in the free state in all but two. The infants varied in age from one-half hour to eighteen hours, and in no instance had received any food or water. The method of obtaining the gastric contents differed from that usually employed only in the use of a glass aspirating bulb.[6] There is no doubt that we did not, at all times, completely empty the stomach. Bearing this in mind, it is the more interesting to find that these new-born infants showed as much as 8 to 10 c.c. of highly acid gastric juice, containing a large amount of free hydrochloric acid. The juice was clear or slightly turbid, somewhat viscid, due to an admixture of mucus, which is secreted freely in this early period, and contained a varying amount of saliva. The saliva is not included in the figures giving the total quantity; as far

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3. Szydlowski, Z.: Jahrb. f. Kinderh., 1892, xxxiv, 411.
4. Zweifel, O.: Untersuch. ueber d. Verdauungsapparat d. Neugeb., 1874.
5. Langendorff, O.: Arch. f. Anat. u. Physiol., lxxix, 95.
6. It is unnecessary to describe this simple instrument, as it has been reproduced in recent articles in connection with an account of duodenal catheterization (Am. Jour. Dis. Child., 1912, iii, 133; Arch. Int. Med., 1912, x, 37.) It has been found exceedingly serviceable in emptying the stomach, for although even with this aid the gastric contents cannot always be completely evacuated, it enables us to obtain a far larger quantity than when aspiration is not employed.

TABLE 1.—GASTRIC SECRETION IN THE UNFED NEW-BORN

Case	Hours Old	Gastric Juice, c.c.	Free HCl	Comb. HCl	Remarks
1	½	2.0	++	....	
2	4½	10.0	+++	....	
3	4½	8.0	60	....	Pepsin rennin.
4	4	8.0	+++	....	
5	5	3.0	+++	....	14 c.c. in one hour.
6	2	5.0	+++	....	17 c.c. in 1 5/6 hours. (See text.)
7	1⅓	3.0	+++	....	
8	¾	?	+++	....	
9	10	1.5	22	....	
10	6	1.0	15	....	
11	2⅔	8.0	20	32.0	Liapse 0.4
12	5	2.0	+++	....	
13	5	6.0	19	37	
14	17½	1.0	+++	....	
15	12¾	2.0	+++	....	
16	5½	2.0	17.5	17.5	
17	7	2.8	45	36	
21	2½	2.0	+++	....	
22	2	1.0	+++	....	
23	8	2.0	+++	....	
24	5⅓	3.0	+++	....	
25	7½	1.0	+++	....	
26	12	1.0	+++	....	
27	12	1.0	+++	....	Lipase 0.3.
28	18	2.0	+++	....	
29	4	3.0	35	50	
30	1½	4.0	+++	....	Lipase 0.2 rennin
31	9	2.0	+++	....	
32	14	5.0	+++	....	
33	5¾	0.5	++	....	
34	5½	0.5	0	....	Saliva marked.
35	5	0.25	++	....	
36	5½	0.5	+++	....	
37	15	0.5	++	....	
38	12	1.0	+++	....	
39	5	3.0	+++	....	
40	6	5.0	+++	....	
41	3	2.0	++	....	
42	7	0.3	++	....	
43	3	8.0	+++	....	
44	5½	12.0	+++	....	Rennin pepsin.
45	5½	0.3	++	....	
46	1½	1.5	++	....	
47	3	1.0	++	....	
48	10	?	+++	....	
49	4	5.0	120	....	
50	2½	1.5	+++	....	
51	2½	2.5	+++	....	
52	7¼	5.0	35.0	37.5	Pepsin rennin.
53	....	1.0	++	....	
54	10	?	0	+	
55	9	2.0	+++	....	

as possible it was removed from the surface of the fluid, so as not to interfere with the acidity tests. For the test of hydrochloric acid Congo paper was used in the clinic, and Toepfer's solution as an indicator for the titration in the laboratory; for the test of combined hydrochloric acid alizarin was employed. We do not wish to insist on the quantitative accuracy of these tests.[7] However, they are probably not too high. For from a quantitative standpoint, all intercurrent disturbing factors, such as admixture of mucus or of saliva, tend to lower the figures for free hydrochloric acid from their level rather than to raise them. Moreover, the figures would seem more accurate than those obtained from older babies on account of the absence of peptones and albumoses which interfere with the activity of the test indicators. We may therefore state not only *that very soon after birth there is free hydrochloric acid, but that there is a considerable amount of this acid in the unfed infant's stomach.* Rennin and pepsin are also present at this time; as a test for the former, milk was used, and for the latter, coagulated egg-white. No quantitative estimation of these two ferments was attempted; their presence in the gastric juice was confirmed several times, and their enzymatic action definite and conclusive. As regards the source and the nature of the lipase, noted in the table, there may be some question. We believe that it is of gastric and not of pancreatic origin, because it was found in fluid which contained no trypsin;[8] Sedgwick[9] found it in the stomach of an infant at the age of 2 weeks, and Ibrahim[10] in a 6-months-old fetus.

The secretion of the gastric juice and the elaboration of the ferments were not brought about by the passage of the stomach-tube. This was evident from the fact that the juice was obtained immediately on passing the tube. In order to test the contrary hypothesis, in several cases the catheter was inserted with the greatest dispatch. This did not lessen the amount of gastric juice obtained. According to Pawlow,[11] the gastric mucosa does not react to mechanical stimulation. Moreover, whatever the nature of the stimulus, all physiologists are agreed that a latent

7. In some instances but 1 or 2 c.c. of fluid was available for titration, so that error undoubtedly resulted in the course of the necessary multiplication of the figures. However, the fact that in several instances a repeated test showed a repetition of the high acidity argues for approximate exactness. This fact is well brought out by the figures in the case of prolonged gastric secretion which are cited below in full. Moreover it will be noticed that, in general and with slight exception, the amount of hydrochloric acid was found to be excessively high.

8. For the lipase tests, neutral ethyl butyrate was used as in the studies of pancreatic ferments (Hess, A. F.: Am. Jour. Dis. Child., 1912, iii, 205.) The figures in Table 1 denote titration against 1/20/n NaOH.

9. Sedgwick, J. P.: Jahrb. f. Kinderh., 1906, lxiv, 194.

10. Ibrahim, J.: Ztschr. f. Biol., liii, 201.

11. Pawlow, I. P.: The Work of the Digestive Glands, second English ed., 1910.

period must elapse before the glands respond. As the result of experiments on animals, Cohnheim[12] places this latent period of the gastric mucosa, following psychic stimuli, at about seven minutes. Pawlow[11] gives the same latent period for the reaction to food. In view of experimental as well as of clinical evidence, it therefore seems certain that in our cases the gastric juice was in the stomach before the passage of the catheter, and was not the result of mechanical stimulation. We shall consider later in greater detail the nature of the secretory stimulus after noting some clinical experiments.

Having assured ourselves that the secretion of hydrochloric acid in new-born infants is the rule, almost without exception, we undertook a more precise investigation of the question. One of the first subjects of inquiry was as to the continuance of the secretion — whether hydrochloric acid and the ferments are in the stomach at the beginning of the test only, or whether they can be obtained throughout long periods. Many tests were made to elucidate this question. We report a few in detail:

REPORT OF EXPERIMENTS

CASE 6.—Nov. 4, 1911. Baby K., 2 hours old. Weight 7 pounds, 9 ounces. Experiment lasting one hour and fifty minutes.

Specimen 1, aspirated after five minutes; 6 c.c. cloudy fluid; moderate amount of saliva; free HCl = 56. (Five c.c. tested.)

Specimen 2, aspirated after 10 minutes; 2.5 c.c. cloudy fluid; moderate amount of saliva; free HCl = 50–55. (Two c.c. tested.)

Specimen 3. Catheter withdrawn; reintroduced after ten minutes' interval; aspiration continued intermittently for fifteen minutes. Three c.c. fluid; marked saliva. Free HCl = 30. (Three c.c. tested.)

Specimen 4. Catheter withdrawn; reintroduced after twenty-five minutes' interval, and aspiration continued intermittently for fifteen minutes; 25 c.c. fluid; slight saliva. Free HCl = 50. (Two c.c. tested.)

Specimen 5. Catheter reintroduced after fifteen-minute interval; aspiration for fifteen minutes; 3 c.c. fluid; slight saliva. Free HCl = 46. (Three c.c. tested.)

Epicrisis.—In a test of an hour and fifty minutes 17 c.c. of highly acid gastric juice was obtained from a new-born infant. No decrease in the amount or strength of HCl secretion was evident during that period.

CASE 30.—Dec. 4, 1911. Baby B., 1½ hours old. Weight 6 pounds, eight ounces. 3 p m., No. 14 F. catheter passed. Gagging slight; 4 c.c. viscid, Congo +++ fluid obtained; saliva marked.

3:05. Catheter reinserted; 3 c.c. Congo +++ fluid. Saliva.

3:15. Inserted into esophagus; saliva and neutral fluid obtained.

3:25. Stomach entered; very slight saliva.

3:30. Stomach contained small amount of Congo +++ juice and saliva.

3:40. Two c.c. Congo +++ fluid with saliva. Baby quiet. Catheter kept steady and not moved about.

3:42. Duodenum easily entered; dry tap after twelve minutes.

3:54. Good retraction test as reentered stomach. About 1 c.c. clear Congo + fluid. No saliva.

3:55. Reentered duodenum. Dry tap after five minutes.

12. Cohnheim, O., and Soetbeer, F.: Ztschr. f. physiol. Chem., 1903, xxxvii, 467.

4:00. Good retraction test. About 2 c.c. Congo +++ fluid in stomach. No saliva.

Epicrisis.—In a test lasting an hour, free HCl was continuously found in the stomach.

CASE 39.—Dec. 28, 1911. Baby U., 5 hours old.

11:55 a. m. No. 14 F. catheter passed. In two minutes 3 c.c. Congo +++ fluid; moderate saliva; pharynx reflex increased; tube washed.

12:00 noon. Catheter introduced into duodenum; marked gagging.

12:10 p. m. Good retraction test; thick mucous. Congo negative; fluid aspirated.

12:15 p. m. Reintroduced into duodenum and retained in place.

12:27 p. m. Retracted into stomach; 0.5 c.c. Congo +, Litmus ++ fluid. Catheter withdrawn.

12:30 p. m. Reentered stomach; 2.5 c.c. Congo + fluid; some saliva.

12:35 p. m. Reintroduced into stomach; 0.5 c.c. Congo ++ fluid.

Epicrisis.—In a test lasting forty minutes, free HCl was repeatedly aspirated from the stomach.

It is evident, therefore, that whatever may be the nature of the stimulus, not only is hydrochloric acid present in the stomach of the new-born, but that *it may be secreted almost uninterruptedly for long periods (hours) quite independent of the ingestion of any food.*

Reference has been made to the fact that in one instance there was an absence of hydrochloric acid. It was not until the thirty-fourth case that a result of this nature was encountered.

CASE 34.—Dec. 18, 1911. Baby F., 5½ hours old; weight 8 pounds, 8 ounces.

2:30. No. 14 F. catheter introduced; small amount neutral Congo negative fluid; slight blood and saliva; pharynx reflex almost absent.

2:35. Reintroduced. Congo negative; litmus negative.

2:38. Reintroduced; 0.5 c.c. fluid, Congo negative; litmus negative.

2:45. Reintroduced; 0.5 c.c. fluid, Congo negative; litmus negative.

2:55. Entered duodenum easily. Dry tap after twenty minutes.

3:08. Entered stomach; 0.5 c.c. saliva neutral, Congo negative fluid.

Epicrisis.—Absence of hydrochloric acid and neutral reaction of stomach contents in five successive tests during a period of thirty-eight minutes.

CASE 34.—Second test.

Dec. 26, 1911; 8 days old; nursed 1¼ hours previously.

3:17. Five c.c. milk aspirated. Congo negative.

3:27. Catheter passed again. Entered duodenum easily.

3:42. Retracted into stomach. Fluid contained saliva, mucus, Congo +.

3:45. Passed into duodenum; 0.6 c.c. fluid containing bile.

4:10. Reintroduced into stomach. During five minutes Congo negative.

CASE 34.—Third test.

Dec. 27, 1911; 9 days old; nursed shortly before test.

2:54. No. 14 F. catheter passed. Two ounces of milk obtained. Congo negative, litmus +.

3:00. Duodenum easily entered.

3:10. Retracted into stomach. Congo negative, litmus +.

3:13. Reintroduced. Congo negative.

Epicrisis.—Retests when the infant was 8 and 9 days old showed HCl present but deficient.

Among the fifty-five infants tested, this was the only one in which there was complete absence of hydrochloric acid at birth. The two later

tests, detailed above, show that acid was being secreted, although in small amount. We are evidently dealing here with a functional disturbance, an anomaly of secretion which may be termed *congenital hypochlorhydria*. Another case (Case 54) should be mentioned in this connection, as it was the only other one in which free acid was not found at birth. However, as the gastric fluid was acid, and the test lasted but five minutes, we must consider that there was merely a deficiency of hydrochloric acid in this case. On the other hand, instances were also met with in which there was a comparative *hypersecretion* of hydrochloric acid; the case (Case 6) cited above as a marked instance of continued secretion may well be brought under this category. We are unable to state the significance of these abnormal variations of secretion. It would be interesting to know how long they persist, or of their possible association with similar conditions in later life.

It is not proposed to consider the gastric secretion of infants who have been put to the breast. However, a few words in this connection may not be amiss, as we carried out a gastric examination on a large group of infants under 10 days of age, incidental to the study of icterus neonatorum. Furthermore, the opportunity was frequently afforded of examining the same infant, first when it was unfed, and later in the course of the first week or two of life. The following case brings out sharply a comparative test of this kind:

CASE 39.—First test; infant 5 hours old.

11:55. Catheter passed. In two minutes about 3 c.c. Congo +++ fluid. Moderate saliva.

12:00. Reintroduced. Easily entered the duodenum; mucus.

12:15. Reintroduced into the duodenum.

12:27. Retracted into stomach. Congo +, litmus ++ fluid.

12:30. Passed into stomach again; 2.5 c.c. Congo + fluid; saliva.

12:35. Reintroduced into stomach: 0.5 c.c. Congo ++ fluid.

Second test; infant 6 days old.

3:38. Catheter passed. About 1 ounce fluid, Congo negative.

3:40. Passed pylorus.

3:48. Retracted into stomach; Congo negative fluid.

3:50. Reinserted into duodenum; thick mucus.

4:01. Reinserted. Some mucus, neutral, Congo negative.

4:05. No. 15 F. catheter inserted.

4:25. Withdrawn; alkaline mucus. Congo negative; material in stomach.

Epicrisis.—Test when 5 hours old (unfed) showed marked hydrochloric acid in stomach and continued secretion for forty minutes. Test when 6 days old showed no hydrochloric acid during forty-five minutes.

It is difficult to explain the fact that in this case and in some others there was a greater secretion before the child had been fed than a few days later. We should have expected to find quite the contrary condition, when we consider that at the time of the first test there was an absolute lack of stimulus from food, which is regarded as a powerful gastric secretogogue. We do not refer merely to the fact that more gastric juice

was found in the stomach soon after birth than later. This might be accounted for by the supposition that it was the product of many hours of secretory activity. But here is an instance in which the stomach, in the case of an unfed infant, continued to secrete acid juice for forty minutes, whereas in the same infant, after it had been nursed for some days, acid secretion was absent or lacking — in a test lasting for a longer period. Evidently the stimulus to gastric secretion is at times more potent at birth than during the early days of infancy.

NATURE OF STIMULUS OF HYDROCHLORIC ACID PRODUCTION

The consideration of the nature of the stimulus of the hydrochloric acid secretion proved a most interesting part of this study. It seemed adapted to investigation, although we realized at the outset that it would be hampered by the limitations which surround all physiologic studies in human beings. On the other hand previous studies of this nature are open to the criticism that they have been carried out on animals, and that their deductions have been presumed to apply to human physiology. But before proceeding further, it may be well to outline the present viewpoint in regard to the normal mechanism of the secretion of gastric juice. Let us follow a standard text-book of physiology.[13] In the first place, it is considered a proved fact as the result of Pawlow's experiments, that "mechanical stimulation of the gastric mucous membrane has no effect on the secretion of the tubules." There are three steps in the mechanism of secretion: (1) The psychical secretion, for which the afferent stimuli originate in the mouth and nostrils, and the efferent path through the vagus nerve; (2) the secretion from secretogogues contained in the food; (3) the secretion from secretogogues contained in the products of digestion. The manner in which the secretogogues act cannot be positively stated. Recently Edkins[14] has suggested, as the result of experiments, that a gastric secretin is formed through the interaction of the food and of the mucous membrane of the pylorus; that this substance is absorbed by the blood, and, acting as a hormone or messenger, is carried to the gastric glands, stimulating them to secretion. According to these views, as given by Howell, we must distinguish between a nervous secretion due to the action of the secretory fibers in the vagus, and a chemical secretion due to the chemical stimulation of secretogogues or of hormones. Viewed from this physiologic standpoint, how are we to interpret the fact that (a) hydrochloric acid and gastric ferments are found in the stomach soon after birth, and (b) that the new-born infant, although unfed, continues to secrete them?

13. Howell, W. H.: Text-Book of Physiology, 1911, p. 763.
14. Edkins: Jour. Physiol., 1906, xxxiv, 133.

It is at once evident that prevailing physiologic views do not account for (a) the secretion of hydrochloric acid immediately after birth. For the exciting stimulus can be neither psychical, "a term which implies that the reflex must be attended by conscious sensations," nor, as we are considering unfed infants, can it be chemical, a secretogogue formed or stimulated by the food.[15] Although this is evident, and it is clear that some other mechanism must exist to account for the secretion at this time of life, we are not prepared to offer a new hypothesis. There are some factors, however, associated with this problem which are worthy of further consideration and discussion. It will be seen from the table (Table 1) that a juice containing hydrochloric acid was obtained as early as one-half hour after birth, and that it was frequently found within the first two hours of life. This secretion may be regarded as either prenatal or postnatal in origin. If the latter view be accepted, we may regard it as in some way connected with the changes in the respiratory and in the circulatory systems, which come about at the time of birth. On the other hand, it may well be that the juice was secreted before birth as the result of an unknown mechanism different from that which obtains in extra-uterine life. This conception of the prenatal secretion of gastric juice, containing hydrochloric acid and ferments, at once raises the question of a fetal gastric digestion, an interesting but at present a purely speculative field.[16]

Let us now turn to the other phase of the problem (b), the continued secretion of gastric juice by the unfed infant. We have stated that likewise this secretion can be neither of reflex origin, that is to say, psychic, nor of chemical origin, namely, due to a secretogogue. In the course of the many tests on new-born babies, observations were noted regarding the effect of mechanical irritation of the stomach, the secretion of saliva, the sucking of the tube by the infant, and other factors, in order to ascertain whether any parallelism could be discovered between these possible stimuli and the degree of gastric secretion. It should be remembered that throughout extended tests we obtained gastric juice containing a high degree of hydrochloric acid. The instances which have been cited above, in which the juice was obtained for twenty minutes,

15. In this connection mechanical stimulation may be left out of consideration, as in many instances the catheter was rapidly passed and the gastric contents obtained immediately on its introduction. A latent period of less than a minute between a mechanical stimulus and profuse secretion is inconceivable and contrary to all experience.

16. Although analogies cannot serve as arguments, we may recall in this connection the prenatal secretion of the liver (bile), of the sebaceous glands (vernix caseosa), and of the glands of the vagina. It should also be considered whether the infant in utero does not perhaps swallow liquor amnii oftener than is generally believed, and whether this fluid may not act as a stimulus to gastric secretion.

forty minutes, or even for an hour or more are not exceptions. It seemed as if we would have ample opportunity to study this question. However, in most instances the phenomena were interwoven and could not be isolated; the infant which sucked the catheter had also a flow of saliva, or, for example, where mechanical irritation was attempted, some secondary factor could not be rigidly excluded. Nevertheless, some cases are worthy of note.

It has been suggested that the saliva may act as a stimulus to the secretion of gastric juice. From this point of view it is significant that, although at times both salivary and gastric secretion were profuse, in the only case (No. 34, cited above in detail) in which no hydrochloric acid whatsoever was found, there was an average quantity of saliva. In another instance (No. 35) hydrochloric acid was obtained on the introduction of the catheter, but could not be found later in the test, although salivation was marked and aspiration was continued at intervals for half an hour. We select these two cases for illustration as they seem conclusive, unless we are to consider them as exceptions to a rule. If not, we must conclude that the saliva does not constitute the essential gastric stimulus in the new-born.

We were not able to control the gastric secretion by mechanical stimulation, that is, to increase it by moving the catheter about in the stomach, or to decrease its flow by maintaining the catheter at rest. But it should be added that as each case differed in the amount of gastric secretion, it would be unwise to draw deductions from individual instances. It seemed as if the secretion of mucus rather than of hydrochloric acid was stimulated by mechanical irritation.

INFLUENCE OF SUCKING ON GASTRIC SECRETION

From the beginning our attention was directed to the influence of sucking on gastric secretion. Some years ago Pfaundler[17] studied this question clinically, and suggested that there is more acid secreted when infants nurse actively than when they are fed passively. The lack of normal standard for gastric juice rendered his figures inconclusive. Cohnheim and Soetbeer[12] investigated this subject on very young puppies, on which an esophagostomy and a gastrostomy had been performed; however, the animals did not live long. The authors came to the somewhat hypothetical conclusion that secretion is a congenital reflex. We approached the question clinically by having the infant suck on a catheter passed as far as the esophagus; this allowed the saliva to be continuously aspirated as it flowed down from the pharynx, but did not entail mechanical stimulation of the stomach. After holding the catheter in this position for a definite length of time, it was rapidly passed into

17. Pfaundler, M.: 16 Verhandl. d. Gesellsch. f. Kinderh., 1899, p. 38.

the stomach and the gastric juice obtained. In almost every test of this nature we found hydrochloric acid. However, we were not able to establish a direct relationship between the length of time of sucking and the quantity of gastric juice. We could not demonstrate that the amount of hydrochloric acid was regularly greater in tests of one-half hour than in those of one-quarter hour, nor could we regularly produce still larger quantities in longer tests. This may have been due to congenital differences of secretion among the various infants, which, as we have shown, exist. Therefore, although our results were not sharp and definite, we believe this method of studying this question on infants deserving of further trial.

In adults the hydrochloric acid of the gastric juice, in addition to its direct function of digestion, is regarded as playing a large part in the regulation of the patency of the pyloric sphincter, and, indirectly, in the secretion of pancreatic juice. Let us briefly consider its relationship to these two phenomena at this early period of life. It has been noted elsewhere that at birth a catheter may readily be inserted through the pylorus into the duodenum. In fact, it can be passed on the new-born with greater facility and with less force than at almost any other period of infancy. Some fifty duodenal tests, made soon after birth, for the purpose of taking cultures, or of obtaining bile or pancreatic ferments, convinced us of this fact. We can therefore state with conviction that a marked tightening of the pyloric sphincter was not associated with the chlorhydria of the new-born; that there was no parallelism between these secretory and motor gastric phenomena. To further test this observation we introduced, in several cases, 1 or 2 c.c. of 0.4 per cent. hydrochloric acid and then passed the catheter. We do not wish to enter into this subject in detail, as we shall consider it at another time in connection with pylorospasm; however, we may summarize these experiments, from the present point of view, with the statement that even following the introduction of the free acid we were able to traverse the pylorus. This accords with the view of most physiologists that hydrochloric acid does not incite closure of the pylorus while it is on the gastric side of the sphincter. This does not, however, exclude the possibility that there may be a relationship between congenital gastric hypersecretion and the development of pylorospasm or of duodenal ulcer, two conditions somewhat peculiar to infancy.

RELATIONSHIP OF GASTRIC AND PANCREATIC JUICES

Finally, a word should be added concerning the relationship of the gastric and the pancreatic juices. In the adult the main stimulus for pancreatic secretion is regarded as the gastric juice, indirectly through its hormone action. In the unfed new-born infant the relationship does

not seem to be so intimate. At this time of life it was at all times difficult to obtain pancreatic juice; in many instances no fluid could be obtained; in others but a fraction of a cubic centimeter. There was a striking disproportion between the large amount of gastric juice and the small quantity of secretion in the duodenum. This lack of concordance may be explained by the supposition that the hydrochloric acid remains in the stomach and does not gain access to the duodenal mucous membrane. Whether or to what extent this is true we have no means of judging. However, in many cases gastric juice entered the duodenum in the course of the passage of the duodenal catheter; in others natural or artificial gastric juice was instilled into the duodenum. Nevertheless, we failed to stimulate pancreatic secretion. In similar tests performed on somewhat older infants we produced at will by this means an increased flow of pancreatic fluid. It is evident, therefore, that at birth the pancreatic secretory mechanism is either functionally undeveloped, or needs a factor in addition to hydrochloric acid to set it in action.

CONCLUSIONS

New-born infants regularly secrete a considerable amount of hydrochloric acid before they are given any food. Among fifty-two infants varying in age from one-half hour to eighteen hours, only one did not have hydrochloric acid in the stomach; in all but one instance free acid was obtained.

The hydrochloric acid varies greatly in amount. Exceptionally it was found almost lacking on repeated tests (congenital hypochlorhydria or hyposecretion), or very profuse (congenital hyperchlorhydria or hypersecretion).

In almost all cases acid was obtained throughout prolonged tests, in spite of the fact that food was not given to stimulate secretion. In one instance 17 c.c. of highly acid juice was aspirated in one hour and fifty minutes. Rennin, pepsin and lipase were also obtained in the (unfed) new-born.

Prevailing physiologic views cannot account for the gastric secretion immediately after birth. It is not the result of mechanical stimulation by means of the catheter, as the juice was obtained immediately on the introduction of the tube, without an intervening latent period. It may be prenatal in origin. Nor is it clear what stimulates the continued secretion which was obtained for hours. Experiments showed that the saliva is not the exciting agent; the effect of sucking could not be determined. Comparative tests of the same infants at birth and later, during the first week of life, showed that the stimulus to gastric secretion may be greater in the new-born infant which has not been fed.

This chlorhydria of the new-born is not usually associated with increased tonicity of the pyloric sphincter, as the duodenal catheter can readily be passed through the pylorus. Even when 0.4 per cent. hydrochloric acid is instilled into the gastric cavity the catheter can be readily passed into the duodenum. However, the high acidity may at times be related to the pylorospasm or to duodenal ulcer met with in infancy.

Although gastric secretion is so marked in the new-born, duodenal and pancreatic secretion is very scanty. Nor can this secretion be readily stimulated by allowing hydrochloric acid to enter the duodenum. Evidently the mechanism of pancreatic secretion is not as easily activated in the new-born as in later infancy.

PROGRESS IN PEDIATRICS

REVIEW OF THE LITERATURE ON NOSE AND THROAT WITH REFERENCE TO CHILDREN

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The lymphatic area of the nasopharynx and pharynx is an immense portal of ingress for infection. Any disease, systemic or local, involving these areas, manifests very rapidly systemic phenomena. In children these areas are particularly susceptible to infection. The digestive tract in children, on account of its incomplete development, requires the closest attention as to diet, as any slight irregularity will produce digestive disturbance, and such digestive disturbance is rapidly manifested in the lymphatic areas of the pharynx and nasopharynx, rendering these areas particularly susceptible to local infections; and in many instances of a sudden febrile condition in children, the real, underlying cause will be found in the intestinal disturbance, and treatment directed toward the removal of this cause will rapidly relieve the pharyngeal and nasopharyngeal symptoms.

In the so-called infectious diseases of children — measles, diphtheria, scarlet fever, etc. — these lymphatic areas are of the greatest importance from the standpoint of diagnosis and treatment. In other words, the lymphatic area of the pharynx — the tonsillar ring and the nasopharynx — is a great barometer to the system. Journalistic literature is replete with reports illustrating just such conditions, and the general practitioner and the specialist should pay particular attention to these areas in diseases of the very young.

CARE OF NOSE AND THROAT IN CHILDREN

Harold Hays[1] states that the most common portal of entry of infection is through the mouth; the nose deserves second place. (a) Whether the tonsils exercise some individual function such as that of an internal secretion is questioned. During the first two years the tonsils should not be removed unless they cause some definite symptoms, such as impairment of breathing, attacks of tonsillitis, or tendency towards suppuration of glands of the neck. If it is necessary to remove tonsils, enucleation is the only operation permissible. (b) Children with high-arched palate and narrow nasal orifices should be referred to the orthodontist. (c)

1. Hays, Harold: Am. Jour. Obstr., November, 1912.

Adenoids, if present, should be removed. (d) The sinuses of the nose are more open to infection than one usually supposes. A so-called cold in the head, discharging pus, excoriations around nostrils, red swollen mucous membrane, are the usual symptoms. For this class of cases Hays recommends the use of a spray in older children and a medicine dropper for younger children, using liquid petrolatum (albolene) having a few drops of 1-10,000 epinephrin solution, or if using boric acid or an alkaline solution, it should be followed by an oily solution.

THE TONSILS IN CHILDHOOD

J. Gordon Wilson[2] draws some very helpful conclusions bearing on tonsillar disease, especially relevant to the pediatrician, which he has made from anatomic and physiologic observations. He says:

> The ease with which the palatine tonsil is observed and the association which it has in the minds of many with all kinds of diseases, lead often to a self-satisfying yet inaccurate diagnosis. Forgetful of its intimate relation to pathologic processes in the nose and naso pharynx, and of its frequent association with systemic disturbances, we too readily diagnose as a primary pathologic condition what is in reality a secondary pathological result. In a tonsillar enlargement we often erroneusly see an active pathologic process instead of a hyperfunctionating organ.

His conclusions are as follows:

> 1. Since comparative anatomy shows that in all cases a communication with the pharynx has been preserved, it would appear that intimate relationship with the pharynx is a necessity to tonsillar activity.
>
> 2. The tonsillar activity is to be regarded as most active during developmental life. There is no evidence that in man it should be regarded as a recessive organ.
>
> 3. The tonsil cannot be regarded as merely a lymphatic node. Though it presents microscopically adenoid tissue, yet its developmental history and its physiologic activity at least make us pause before drawing such a conclusion. It is just this presumption that has led many to a hasty and unnecessary enucleation. The statement some have made that since the tonsil is only a lymphatic gland, its activity can readily be replaced by other lymphatic structures, is of very doubtful merit, even so far as lymph-nodes are concerned, and erroneous so far as the tonsil in the child is concerned.
>
> 4. We have every reason to believe that the tonsil plays an important rôle in the complex changes which occur at the upper end of the alimentary tract. The argument that no one has seen any local or systemic deficiency following removal of tonsils in childhood is not satisfactory, since we have not sufficient observations based on complete enucleations.

From these anatomic and physiologic considerations, the author distinguished in the life-history of the tonsil two distinct periods:

(a) Before puberty — period of functional activity.

(b) After puberty — when it persists chiefly as an aggregate of lymph-nodules which tend to atrophy.

The influence which these observations have on the author's views in regard to tonsillar diseases, and their treatment, is:

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2. Wilson, J. Gordon: Am. Jour. Dis. Child., 1912, iii, 277.

In the child it should be conservative, so far as possible, and the younger the child the more conservative; in adults, let it be radical whenever necessary.

He then goes on to apply these deductions to some varieties of tonsillar disease. Throughout the paper the author takes the part of the often massacred tonsil, and pleads for it a more unprejudiced study than has heretofore been given it.

RELATION OF ADENOIDS AND RECURRENT VOMITING

J. P. Sedgwick[3] reviews the theories advanced concerning the etiology of recurrent or periodic vomiting and reports a series of twenty-two cases, of which twenty patients had adenoids or enlarged tonsils. Most of them had fever before or during the attack. The posterior cervical lymph-nodes were enlarged. A very common prodrome of the attack was sore throat or nasal discharge. One "had bleeding nose at the time of the attacks." Geographical tongue and asthma were noted. He also shows by the detailed report of eight cases that these attacks were either improved or entirely relieved since the removal of the adenoids.

RECURRING ADENOIDS IN CHILDREN

L. Fischer[4] points out that a recurrence of adenoid vegetation may be due to lack of proper aseptic precautions at the time of operation. If, however, these were taken we should look for syphilis as the underlying factor. In such cases the Wassermann reaction will be found of great diagnostic value.

T. Guthrie[5] feels that true recurrence of adenoid tissue seldom occurs, if the removal was complete and the surface was left smooth and free from any palpable fragments. When the child is under 4 years the chances of recurrence are much greater; between 4 and 7 the risk is less, and after 7 years almost *nil*. Recurrence is favored by an attack, within a short time of the operation, of one of the specific fevers (measles or whooping-cough); by congenital syphilis, or by the presence of untreated anterior nasal obstruction, especially hypertrophied inferior turbinals.

ACUTE RHINITIS IN THE NEW-BORN

Rabasa[6] points out that coryza is not only a troublesome, but also a serious affection in childhood, because the nasal obstruction interferes considerably with feeding and also causes complications in the ears (otitis) or larynx (glottic spasms). The origin and therapy are discussed. Rabasa prefers the suction treatment by means of the Escat apparatus or an ointment of resorcin and aristol to other methods.

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3. Sedgwick, J. P.: Am. Jour. Dis. Child., 1912, iii. 318.
4. Fischer, L.: Jour. Am. Med. Assn., Jan. 13, 1912, p. 106.
5. Guthrie, T.: Lancet, London, April 20, 1912.
6. Rabasa: Bol. med., April, 1912.

A FAMILY WITH MEMBRANOUS DISCHARGE FROM NOSE

A. M. Gossage[7] says that fibrinous rhinitis is not uncommon in children, and is associated with fibrinous or membranous exudation. It generally persists for six to eight weeks. A bacillus very closely simulating the Klebs-Loeffler is most generally found.

Baumgarten describes a case of a baby who had crust formation in the nose from birth, which, when removed, would reform in three to four days. Iodoglycerin was used to douche the nose, after which crusts did not reform. There was an odor from the nose at 3 years, and ozena at 4 years of age. Mother had ozena, but other children normal.

Gossage came across a family with several members having membranous discharge throughout life. No signs of ozena. Complete fibrinous casts were obtained from father and two children, reforming every twelve hours. Pathologically, they showed polymorphonuclear cells in fibrinous network. There were no bacilli, diplococci or diplobacilli present. History shows four generations affected.

PATHS OF RHEUMATIC INFECTION AND THEIR PROTECTION IN CHILDREN

J. R. Mackenzie[8] says that the rheumatic infection may be localized in the throat, bronchial tubes or unhealthy intestinal tract; the micrococcus makes inroads if the physical resistance, the protective properties of the local tissue or the defensive agencies of the blood are subnormal. In a child of a rheumatic family, congestion of the pharynx, palate and fauces should always receive immediate attention; salicylic acid preparations, with sodium bicarbonate, sodium salicylate, potassium chlorate and aperients are effective. The hygiene of the mouth should also receive careful attention.

PERMANENT WHEEZING IN A YOUNG INFANT DUE TO SIMPLE TRACHEOBRONCHIAL ADENOPATHY

Halpire and Carpentier[9] report a case in which, since the age of 3 months until death following bronchopneumonia complicating measles, the child had a persistent wheezing due, it was thought, to hypertrophy of the thymus. The mother had presented a similar condition, when young, which gradually disappeared. Neither during life nor at autopsy could any tuberculous lesions be found, but a very pronounced intertracheobronchial adenopathy involving the tenth pair and the recurrent nerve. Persistent wheezing is exceptional and usually ends fatally in infants.

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7. Gossage, A. M.: Brit. Jour. Child. Dis., April, 1912, p. 157.
8. Mackenzie, J. R.: Brit. Med. Jour., June 1, 1912, p. 1232.
9. Halpire and Carpentier: Rev. méd. de Normandie, Feb. 25, 1912.

CONDITION OF NOSE, THROAT AND EAR AS FACTOR IN EXCEPTIONAL DEVELOPMENT

O. Glogau[10] bases his conclusions on a study of exceptional children in Herbart Hall. He found nasal obstruction with or without adenoids and tonsils present in both the advanced and the backward child. On the other hand, defects in the sound-conducting and sound-perceiving apparatus resulting in decreased hearing-power was only found in the backward children; in fact, the advanced type showed over-acute audition. This latter fact Glogau advances as a possible explanation of the musical prodigy. The function of the static apparatus of the labyrinth was found to be markedly impaired in the backward child, while in the exceptionally bright child an over-irritability was noted.

A BRIEF REPORT OF AN EPIDEMIC OF SORE THROAT WITH INVOLVEMENT OF THE CERVICAL LYMPH-NODES

John Ruhräh[11] reports that in 600 odd cases of epidemic sore throat there were twenty-eight fatalities. Complications were severe and numerous; 30 to 40 per cent. had otitis media, nearly as large a number had irregular swellings of the neck over the epiglottis, base of tongue, etc., suppuration being unusual. Edema of the eyes was common, as was bronchitis and pneumonia as a complication; also gastro-intestinal disturbances; three cases of erysipelas and involvement of tissues around joints.

A diplococcus, often in pure culture, was isolated from a number of patients; had a distinct capsule, being Gram-positive. Nearly 80 per cent. of the children were using milk from one dairy, which had temporarily discontinued its customary pasteurizing of milk, the weather at this time being extremely cold.

CONGENITAL EDEMATOUS PROLAPSE OF THE NASAL MUCOUS MEMBRANE IN THE NEW-BORN

N. Calamida[12] (Milan) reports the following two cases: Case 1. In a baby of 20 days a polypus projects from the right nostril. It is of the size of a small nut and of pinkish color. Breathing is interfered with. The growth is removed by the cold wire snare. Microscopic examination reveals the presence of juvenile connective tissue impregnated with serum; there is also present a small cell infiltration limited to the subepithelial layer.

Case 2. The left nostril of a baby of 24 days is obstructed by a polypus similar to the one described above. By instillation of menthol,

10. Glogau, O.: Am. Jour. Obst., January, 1912.
11. Ruhräh, John: Am. Jour. Dis. Child., November, 1912.
12. Calamida, N.: Arch. Internat. de Laryngol., 1912, xxxiv, 61.

cocain and epinephrin the growth soon shrunk and nasal breathing was restored. The author considers this condition to be a congenital edematous prolapse of the nasal mucous membrane.

REMOVAL OF ADENOIDS AS PREVENTIVE MEASURE AFTER EXPOSURE TO MEASLES

J. B. Greene,[13] appreciating the great danger of a suppurating ear complicating measles in the presence of a large adenoid, believes that in such adenoid cases surgical intervention becomes conservative treatment after exposure to measles. He quotes a case in support of his contention.

A CASE OF FATAL HEMORRHAGE FROM THE THROAT

J. D. Rolleston[14] reports the case of a girl, aged 6 years, who was admitted to the hospital October 22, certified to be suffering from diphtheria. She had had measles five weeks previously, since which time her voice had been husky. October 20 she complained of sore throat, and October 22 she had a croupy cough and her neck glands became swollen.

Condition on admission: Deposit on both tonsils and uvula, slight nasal discharge, voice husky, stridor, croupy cough and dysphagia. Temperature 100 F. Sixteen thousand units of antitoxin given.

October 22. Deposit clearing away, leaving marked ulceration of tonsils and uvula. No fetor. No Vincent's organisms in throat smear. Temperature 100.2 to 100 F.

October 25. Sudden and profuse hemorrhage from throat, cyanosis and death within five minutes. No diphtheria bacilli, but only cocci were found in three successive cultures from throat and one from nose.

Necropsy, October 26. Abscess cavities in both tonsils; ulceration of uvula, soft palate, epiglottis, frenum epiglottidis, valleculae and ary-epiglottidean folds. Deep ulceration of laryngeal portion of pharynx exposing muscular tissue. Three small superficial ulcers above right vocal cord. The exact site of the bleeding vessel was not determined, but there was no evidence of erosion of external carotid, internal carotid or internal jugular, nor any glandular abscess.

Walter B. Maurice[15] reports a similar case, the patient being a boy, aged 6 years, sent to the hospital with supposed mastoid abscess. On examination he was found to have no mastoid trouble, but a much enlarged tonsil on the left side and free hemorrhage from the left ear. He had a fairly high temperature. The blood coming from the ear was bright and not mixed with pus. The following day marked respiratory obstruction was present and the tonsil was opened by the introduction of

13. Greene, J. B.: Med. Rec., New York, 1912, ii, 388.
14. Rolleston, J. D.: Brit. Jour. Child. Dis., February, 1913.
15. Maurice, Walter B.: Brit. Jour. Child. Dis., May, 1913.

a pair of sinus forceps. No pus was evacuated, but the condition improved. For the next day or two the child seemed much better, but more hemorrhage occurred from the ear and temperature remained high. On the third day, while playing he suddenly gushed up a quantity of blood from the throat and dropped back, instantly dead. No post mortem was permitted, but from the great rapidity of death, the source of the hemorrhage was believed to be the carotid. The strangest feature was the hemorrhage from the meatus beforehand. The condition was obviously a septic one from the start, but there was no history or evidence of scarlet fever.

PERTUSSIS: THE HISTOLOGICAL LESION IN THE RESPIRATORY TRACT

F. B. Mallory and A. A. Hornor[16] conclude, from a microscopic study of the trachea and lungs from three patients who died of whooping-cough, that this disease is due to a minute bacillus which occurs in large numbers between the cilia of the epithelial cells lining the trachea and bronchi and possibly also the nose. The location of the organism is apparently characteristic for the disease. Its action seems to be largely mechanical. It interferes by its presence with the normal movements of the cilia and possibly leads to their destruction.

The mechanical interference with the action of the cilia, and possibly their destruction, prevent the normal removal of secretion. The bacilli and the secretion produce a continuous irritation which results in coughing, and usually also in the characteristic spasm known as whooping.

Believing that the bacillus found in the lesions was in all probability identical with the organism discovered and described by Bordet and Gengou, they subsequently[17] carried out experiments on animals which proved that the organism corresponded in every way with the Bordet-Gengou bacillus.

The failure up to the present time to observe the bacillus of whooping-cough in its peculiar and characteristic location in the respiratory tract is probably due to its small size and to its staining but faintly by ordinary methods.

The reason the Bordet-Gengou bacillus has not been unqualifiedly accepted as the cause of whooping-cough is largely due to its presence having been demonstrated only in connection with the disease, not in connection with any evident lesion. It might have been a secondary invader like the streptococcus in scarlet fever.

Mallory and Hornor have demonstrated the primary essential lesion of the disease and the characteristic relation of the causal agent to it. In addition, they have been able, with sputum and with pure cultures of a micro-organism corresponding in every way with the Bordet-Gengou

16. Jour. Med. Research, xxvii, No. 2, Nov., 1912, p. 115.
17. Jour. Med. Research, xxvii, No. 4, March, 1913, p. 391.

bacillus, to produce the same characteristic lesion in young animals and in four instances (one puppy and three young rabbits) to obtain the organism again in pure culture. Moreover, they have produced the same lesion in the nares, trachea and bronchi of a young rabbit after infecting it through the nares with a subculture of the bacillus obtained originally from Bordet, and were able to grow the micro-organism again in pure culture. They have, therefore, supplied the steps which have heretofore been lacking, according to Koch's laws, for the complete demonstration that the Bordet-Gengou bacillus is the cause of whooping-cough. This result should encourage further investigation in search for a vaccine or antitoxin which may be of use in the treatment of the disease. The diminution in numbers and final disappearance of micro-organisms under ordinary conditions in the course of comparatively few weeks strongly suggests that conditions for growth become unfavorable, probably owing to the development of some antibody.

VACCINE THERAPY OF WHOOPING-COUGH

C. Nicolle and A. Conor[18] recently presented before the Academie des Sciences, Paris, the results of their attempts at vaccination of whooping-cough by inoculation of living cultures of Bordet's bacteria, which they used during the epidemic which raged in Tunis last spring. These cultures on agar-potato-blood, made into an emulsion in physiologic salt solution, were kept at 46 C. (114.6 F.) for thirty minutes, which does not affect their vitality, then repeatedly washed and centrifuged so as finally to obtain a perfectly homogeneous emulsion of bacteria, isolated and deprived of all foreign substances. For use in vaccination, each drop of the emulsion (representing about 400 million bacteria) is diluted with 2 c.c. of physiologic salt solution. Because of the difficulty of intravenous inoculation of very young children, Nicolle and Conor inject it under the skin of the thigh, from 1 to 5 drops of emulsion each time. They have observed no general or local reaction. Of 122 children treated thus, 18 have not been seen after the first inoculation. Of the remaining 104, there have been 37 cures (complete cessation of cough), or 35.37 per cent.; 40, or 38.46 per cent., improved (notable diminution of cough) and 27, or 25.96 per cent., remained stationary. In the cases of cure, improvement became manifest very rapidly, generally on the first or the second inoculation. The nightly coughing spells diminished in intensity and number. Out of the 37 cures, 29, or 78.38 per cent., occurred after from two to five inoculations; that is, in from three to twelve days. In view of the often discouraging duration of whooping-cough, the results obtained by Nicolle and Conor are distinctly encouraging.

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18. Jour. Amer. Med. Asso., lxi, No. 3, July 19, 1913, p. 209.

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